OPERATIVE SURGERY

VOLUME THREE

OPERATIVE SURGERY

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VOLUME THREE

0-79

RECTUM AND ANUS

THORAX

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PART IV

RECTUM AND ANUS

PART IV RECTUM AND ANUS

PROCTOSCOPY

H E Lockhart-Mummery M B M Chir F R C S

Surgeon St Mark s Hospital London

PRE-OPERATIVE

Indications

Proctoscopy is most useful in the examination of the anal canal and the region of the ano-rectal ring and particularly in the detection of haemorrhoids. For satisfactory examination of the rectum and its mucosa sigmoidoscopy is to be preferred.

Injection of haemorrhoids, and other minor manipulations in the same area can be carried out with ease through a well-lighted proctoscope of adequate size.

Contra-indications

The anus must be carefully inspected and a finger passed before any instrument is inserted. In this way the presence of any painful lesion such as a fissure or thrombosed haemorrhoids will be detected proctoscopy is then usually contra-indicated unless adequate local anaesthesia can be produced.

In children or in patients with anal stenosis a proctoscope of smaller size should be used.

Pre operative preparation

No special preparation is necessary Enemas are undesirable, but the patient should be encouraged to empty the bowel naturally before coming for examination If the bowel is very loaded, the examination is best deferred.

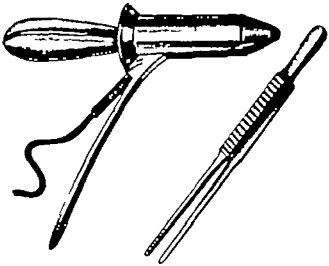
Anaesthesia

No anaesthetic is necessary for most patients. Satisfactory local anaesthesia of painful fissures can usually be obtained by application for 5 minutes of 2 per cent amethocaine in solution or of Xylocaine ointment

Position of patient

The Sims position as described for Sigmoidoscopy Part III page 485 is very satisfactory The knee-chest position may sometimes be preferred for male patients.

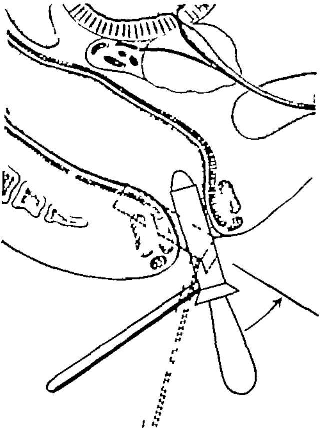
PROCEDURE



Instruments

Proctoscopes of many types and sizes are available. The one illustrated is a tubular proctoscope incorporating a lighting system (internal diameter ¾-inch) This is the most useful type for most purposes, and will be found more satisfactory than slotted or conical instruments. It is made in several sizes.

Long forceps for swabbing through the proctoscope are invaluable. Illustrated are Emmett's 8-inch forceps.



Insertion

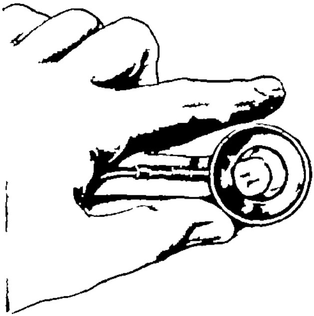
The proctoscope, well lubricated, is passed gently into the anal canal, pointing towards the umbilicus. The rectum and anal canal join at an angle, so once the tip of the proctoscope has entered the rectum, the direction of insertion should alter and the instrument should now point towards the sacral promontory

The obturator is removed, the light is attached, and the ano-rectal region and anal canal can be clearly seen as the instrument is slowly withdrawn

The pink mucosa of the normal rectum should be noted. Internal haemorrhoids will prolapse as the instrument is slowly withdrawn and are best seen if the patient is asked to strain

Examination

3 The handle of the instrument is held in the left hand so that the right is free for manipulations. It is often helpful to use the left index finger as shown to hold the upper buttock out of the line of vision.
Before finally withdrawing the instrument the obturator should be replaced, as discomfort is thereby lessened.

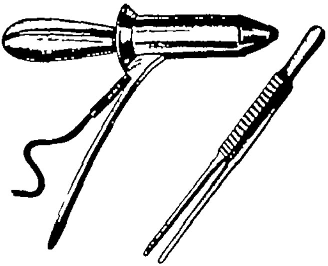


POST-OPERATIVE

No special care or treatment is necessary. The patient may leave the hospital as soon as the examination is completed.

[The illustrations for this Chapter on Proctoscopy were drawn by Mr. R. N. Lane.]

PROCEDURE



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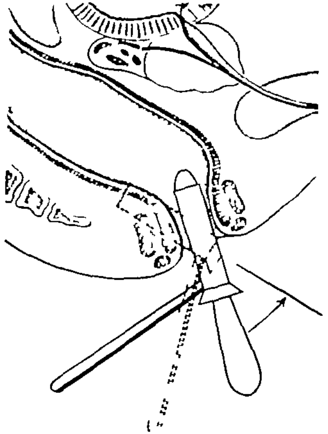

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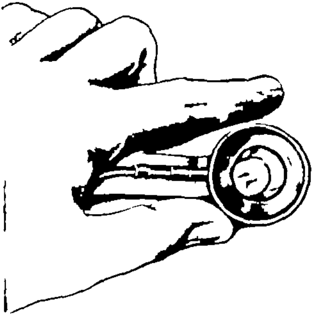

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[*The illustrations for this Chapter on Proctoscopy were drawn by Mr R. N. Lane*]

INJECTION OF HAEMORRHOIDS

H. E. LOCKHART-MUMMERY M.B., M.CHIR., F.R.C.S.
Surgeon St. Mark's Hospital London

PRE-OPERATIVE

I ...

...ection treatment gives excellent results in first-degree haemorrhoids and in some cases of second-degree ... Results are less satisfactory in more advanced cases, but this may nevertheless be the treatment of ... in old people in those considered unfit for operation, and during pregnancy

...ecial contra-indications

... ons are contra-indicated in an acute attack that is with recent thrombosis of a haemorrhoid. Large prolapsing haemorrhoids are not likely to respond to injections. Any associated chronic fissure or fistula ... renders operation necessary The presence of a rectal neoplasm or of procto-colitis must always be excluded ... sigmoidoscopy before starting a course of injections.

... general and abdominal examination should be carried out before starting a course of injections, in order to ... conditions such as heart failure or portal hypertension, for which other treatment is needed.

...e-operative preparation

No special preparation is necessary The rectum should not be loaded, and a normal evacuation on the morning of ... day of treatment is the best preparation.

...

The injection if properly given is painless, and should lead only to a slight feeling of rectal distension which soon ... off. No anaesthetic, local or general, is needed.

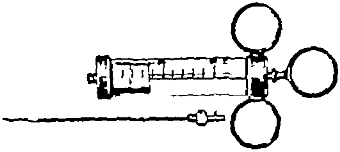
...ion of patient

The Sims's position with the pelvis raised on a sandbag as described under Sigmoidoscopy Part III, page 485 is ...le for the patient and convenient for the surgeon.

THE OPERATION

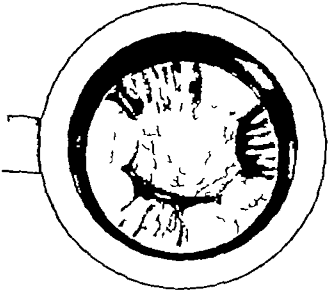
Instruments

1 A tubular illuminated proctoscope as already illustrated (Part IV page 6) is the one preferred A 10 ml syringe with 3 finger grip fitted with a long needle attaching by a bayonet lock, is used for injection The solution used is 5 per cent phenol in vegetable oil with 2 gr of menthol to the ounce Total dose at one time should not exceed 10–15 ml



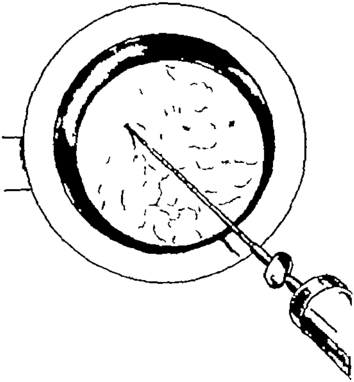
Place to inject

2 All three haemorrhoids may be injected at one time if necessary The proctoscope is passed and the patient must relax and not strain. The proctoscope is moved and tilted until the proposed site of each injection is clearly seen This should be into the pedicle of the haemorrhoid just above the level of the ano-rectal ring

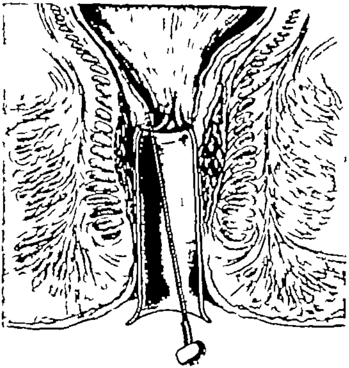


The injection

3 The solution is injected submucously and should flow with light pressure The area of injection should be watched, and the mucosa should be seen to bulge and become a pearly yellow as the injection proceeds and the solution spreads in the submucous layer If a dead white patch appears, the injection is too superficial and must be immediately stopped the needle should be re inserted in another spot. The usual dose is 8 ml of the 5 per cent solution in each haemorrhoid.



As shown in the diagram the injection is given above the ano-rectal ring and should therefore cause *no pain* to the patient, only a mild discomfort and sense of distension.
Should bleeding occur when the needle is withdrawn, it is easily arrested by a few *minutes pressure with a cotton-wool swab*



POST-OPERATIVE CARE AND COMPLICATIONS

The patient is advised to avoid physical exertion or long standing on the day of the injection. The next bowel ovement should if possible be postponed till the day after the injection.
A sense of fullness and heaviness in the rectum may persist for about 24 hours.

ulcer

This should not occur if the correct solution is used and the injection given in the submucous plane, but may llow an intra-mucosal injection. Such an ulcer is usually painless but may bleed, and quite severe haemorrhage y result if a large vessel is eroded. Treatment is then by packing, as described under Secondary Haemorrhage Haemorrhoidectomy (Part IV page 22) Otherwise no treatment is called for and healing of the ulcer occurs

ther complications

Haematuria from puncture of the prostate and submucous abscess are rare complications. Stricture of the rectum d paraffinoma do not occur if a 5 per cent phenol solution in vegetable oil is used for injection as recommended.

injections

Injections may be repeated if necessary but it is seldom advisable to give a further injection until all palpable from the previous one has disappeared. This usually takes 3–4 weeks.

[*The illustrations for this Chapter on Injection of Haemorrhoids were drawn by Mr R. N Lane*]

Reference

Gabriel, W B (1949). *The Principles and Practice of Rectal Surgery* 4th Ed., p 73. London H. K. Lewis.

FISSURE-IN-ANO

H. E. LOCKHART-MUMMERY M.B., M.CHIR., F.R.C.S.

Surgeon St Mark's Hospital London

PRE-OPERATIVE

Indications

Any chronic or recurrent anal fissure requires operation for its cure. Signs of chronicity are considerable depth and fibrosis or induration of the base. A fissure is unlikely to heal without operation if there is a fibrous polyp at the apex, or large prolapsing haemorrhoids. Active infection as shown by the presence of pus, undermining or a dorsal fistula is also an indication for operative treatment.

The not uncommon association of a fissure with prolapsing haemorrhoids can be dealt with in one operation. The wound resulting from treatment of the fissure can usually be incorporated in the right posterior haemorrhoid wound.

Special contra indications

As explained under Haemorrhoidectomy (Part IV page 17) operation is best avoided in the presence of dysenteric infection, procto-colitis, or pulmonary tuberculosis. During pregnancy palliative treatment usually suffices until after delivery.

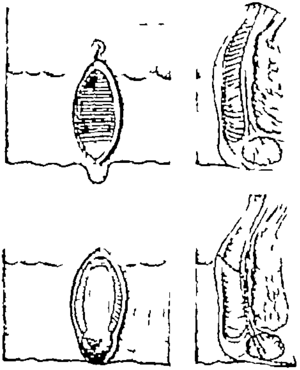
Anaesthesia, pre operative preparation and position of patient

Light general anaesthesia supplemented by local has proved very satisfactory. In general the preparation and position of the patient are as described in the chapter on Haemorrhoidectomy (Part IV page 17).

THE OPERATION

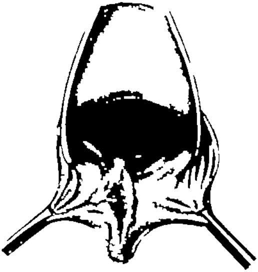
Principles

1 A cut is made through the fissure to divide the fibrous tissue in its base, the lower half of the internal sphincter muscle, and part or all of the subcutaneous external sphincter, thus relieving anal tightness and spasm. Any anal papillae are cut off and the wound is suitably trimmed and extended radially to excise any sentinel tag and allow some external drainage.



Exposure

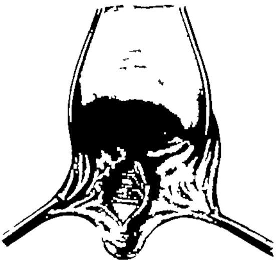
A Sim's or duck-bill speculum is inserted into the anal canal and held by an assistant. Gentle radial traction is made on the skin posteriorly with light holding-forceps and the posterior wall of the anal canal and the fissure are displayed.



The incision

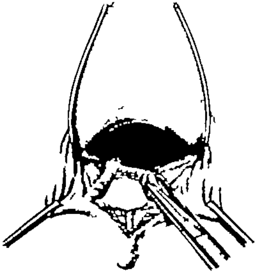
Incision through the base of the fissure

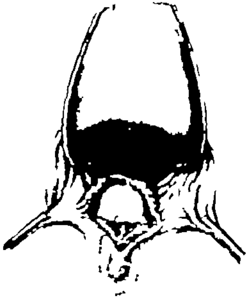
3 A longitudinal cut is made through the base of the fissure the mucosa above it and the skin below it. The circular fibres of the internal sphincter and the fibrous tissue under the fissure are displayed. The cut is continued to divide the circular fibres of the internal sphincter and any fibrous tissue, or tight fibres of the subcutaneous sphincter at the anal verge.



Division of the internal sphincter

4 The appearance of the glistening fascial layer covering the longitudinal muscle shows that the internal sphincter has been fully divided. The upper part of the internal sphincter muscle above the dentate line, is seldom tight and need not be cut. With scissors, the overhanging edges of the wound in the anal canal are trimmed away and any papillae excised.





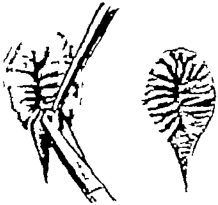
Excision of sentinel tag, wound trim

5 The external wound is enlarged by excising any sentinel tag present, and then trimming away any wound edges that tend to overhang

Trimming the wound edges

6 The speculum is removed, and when the anus closes to its normal size, the wound is inspected extended as necessary to allow adequate external drainage and the edges further trimmed if necessary It should extend about 1 inch from the anal verge and be about ½ inch wide A finger should enter the anal canal smoothly Any residual fibrous ridge at the anal verge should be further divided until the wound feels smooth.

A soft Paul's tube is inserted into the anus and a flat moist dressing applied.



POST-OPERATIVE CARE AND COMPLICATIONS

The after-care of the wound and the management of the patient's bowels are carried out as described under Haemorrhoidectomy The daily passage of a finger or dilator should start rather earlier on the fourth or fifth day as there is rather more tendency for the wound edges to fall together and result in delayed healing or a pocket of infection.

The complications of urinary retention, reactionary haemorrhage, and sub-scar fistula may occur as described in Haemorrhoidectomy and should be dealt with in the same way

[The illustrations for this Chapter on Fissure in-Ano were drawn by Mr R. N Lane]

Bibliography

Eisenhammer S (1951) *S Afr med J.*, **25**, 490.
Gabriel, W B (1930). *Brit med J.*, **2**, 811
Gallagher J. C., Leacock, A G., and Brown J-J (1955) *Brit. J Surg* **43**, 57

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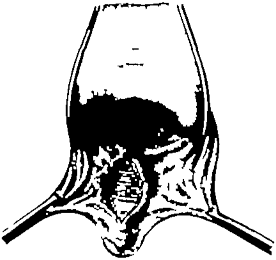

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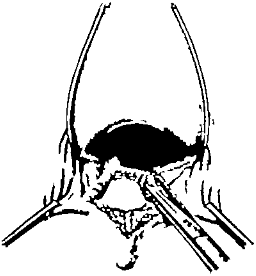

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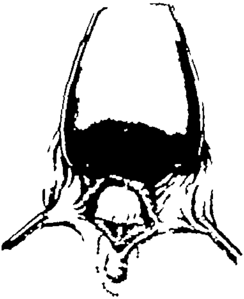

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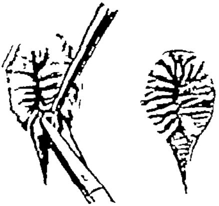

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Bibliography

Eisenhammer S. (1951) *S Afr med. J* **25**, 486.
Gabriel, W B (1930) *Brit. med J.*, **2**, 311
Goligher J C Leacock, A. G., and Brossy J J (1955). *Brit J Surg.*, **43**, 67

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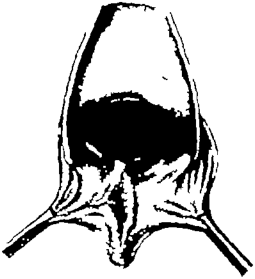

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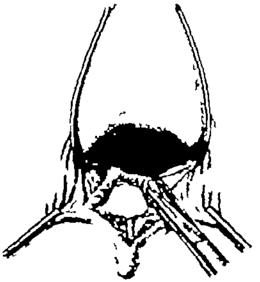
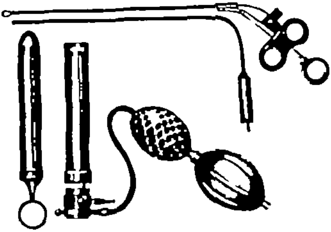
Division of the internal sphincter

4 The appearance of the glistening fascial layer covering the longitudinal muscle shows that the internal sphincter has been fully divided. The upper part of the internal sphincter muscle, above the dentate line, is seldom tight and need not be cut. With scissors, the overhanging edges of the wound in the anal canal are trimmed away and any papillae excised.



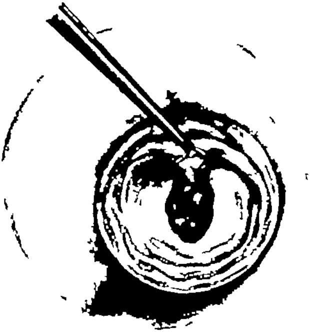
THE OPERATION



1

Instruments required

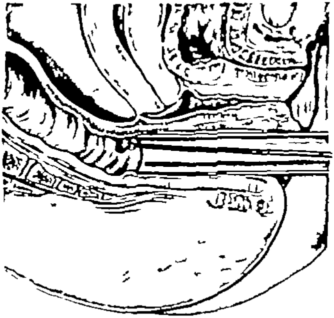
Operating sigmoidoscope The one illustrated is the Lloyd-Davies pattern with an internal diameter of $1\frac{1}{16}$ inch and lengths of 15 cm or 20 cm Wire diathermy snare for use through the sigmoidoscope Long diathermy button A large bore sigmoidoscope is essential for accurate endoscopic work though general or local anaesthesia is needed before it can be passed



2

Use of diathermy snare

The sigmoidoscope is introduced under vision until the polyp and its stalk are clearly seen The size of the wire loop of the snare is adjusted so that it can be passed over the polyp The loop is passed through the sigmoidoscope manipulated over the polyp and then gradually tightened until it is seen to be gripping the stalk near its attachment to the bowel wall The polyp is then pulled gently away from the wall, and a low intensity cutting diathermy current is run through the wire in repeated short (¼ second) bursts as the wire is further tightened, until the pedicle is cut through. Any oozing of blood is usually very slight and can be arrested with a small swab soaked in liquor adrenaline 1 1 000



3

Use of diathermy button

Smaller sessile polyps are usually best dealt with by means of the long diathermy button They are destroyed by short touches with the button, using a low intensity cutting current

RECTAL POLYP

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Surgeon St Mark's Hospital, London

PRE-OPERATIVE

precautions

Any rectal polyp is potentially precancerous and should therefore be removed. Sigmoidoscopy and opaque should be carried out in every case before removal, as other polypi may be so demonstrated in the colon, or associated malignant growth detected. In such cases different treatment may be required.

Any polyp removed should always be examined microscopically

A polyp should be suspected of having undergone malignant change if it is unduly hard, or ulcerated, or if the or base feels indurated. In such circumstances, biopsy rather than total removal is usually wiser as more radical will probably be needed.

ive preparation

A clean empty bowel is necessary and a high colonic washout, continued until the fluid is returned clear ensures No other preparation is needed.

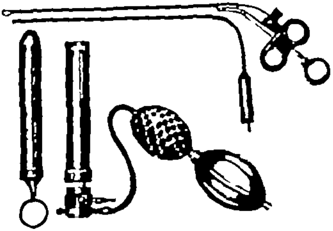
naesthesia

An anaesthetic is necessary in most patients before the large-bore operating sigmoidoscope can be passed. General sthesia is usual, but local anaesthesia to the anal region as described for Haemorrhoidectomy (Part IV page 17) be given instead if preferred.

of patient

The Sim's position, but with the buttocks over the edge of the table and raised on a sandbag is convenient. The sits behind the patient

THE OPERATION



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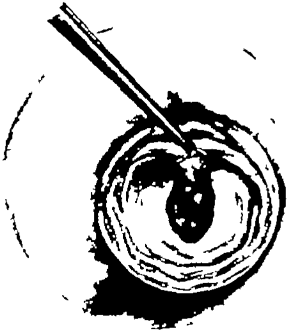

Use of diathermy snare

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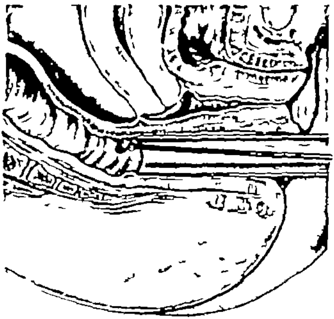

Use of diathermy button

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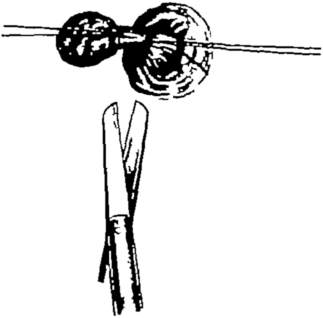

Ligation of pedicle

Pedunculated polyps in the lowest part of the rectum can often be delivered outside the anus when the sphincter is fully relaxed. The pedicle may then be transfixed and ligated and the polyp removed.

POST-OPERATIVE CARE AND COMPLICATIONS

The patient should be detained in hospital for the night following the operation but no special treatment is ed

Perforation of the bowel wall

Signs of lower abdominal peritonitis, for example pain, guarding and rigidity develop within a few hours. Laparotomy is necessary the hole should be sutured, the peritoneum mopped clean and dry and the abdomen closed with a drain down to the site. Temporary sigmoid colostomy is advisable if the perforation is large. Antibiotic therapy should be given.

Secondary haemorrhage

This may occur when the slough caused by the diathermy separates usually between the sixth and tenth days. It is seldom severe and usually ceases spontaneously The application of an adrenaline swab through a sigmoidoscope will arrest the bleeding if it should fail to stop on its own.

[The illustrations for this Chapter on Rectal Polyp were drawn by Mr R. N Lane]

Bibliography

Lockhart Mummery H. E., and Dukes, C. E. (1952). *Lancet*, 2, 751
Swinton, N W., and Holt, J H. (1951). *Surgical Practice of the Lahey Clinic* p. 391 Philadelphia W B. Saunders.

HAEMORRHOIDECTOMY

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PRE-OPERATIVE

Indications

The choice of treatment for haemorrhoids depends to some extent on the patient s wishes for good palliation may often be achieved by injections Prolapsing haemorrhoids, especially those needing manual replacement, or the association of other anal pathology such as a fistula or chronic fissure usually indicate the need for operation.

Special contra-indications

All operations on the anal region are best avoided in the presence of any dysenteric infection, or of granular proctitis or ulcerative colitis not only are the wounds likely to be slow to heal and indolent, but the colitis may be severely aggravated by the operation Operation should be avoided on patients with open pulmonary tuberculosis, as there is some risk of tuberculous infection of the anal wounds.

Prolapsed, thrombosed haemorrhoids should not be operated upon until the acute stage has quite settled, usually a matter of 3–4 weeks.

During pregnancy palliative treatment is needed, for the anal condition will improve after delivery In old people, palliation by injection is usually the best treatment.

Sigmoidoscopy is essential in every patient before haemorrhoidectomy is undertaken, to ensure that no rectal disease is present and particularly to exclude a neoplasm.

Pre operative preparation

The patient should be admitted to hospital the afternoon before operation a simple soap-and-water enema is given, the anal region shaved, and the patient should have a bath On the morning of the operation a small rectal washout is given with a tube and funnel and the fluid siphoned back.

Anaesthesia

Light quiet general anaesthesia supplemented by local anaesthesia is ideal A local anaesthetic (with adrenaline) to the anal region gives perfect sphincter relaxation and a bloodless field. One ampoule (20 mL) of Xylocaine 2 per cent with adrenaline 1 in 80 000 has proved very satisfactory

Position of patient

The patient should be in the lithotomy position with the buttocks lifted well down over the edge of the table the lower flap of which should be removed.

THE OPERATION

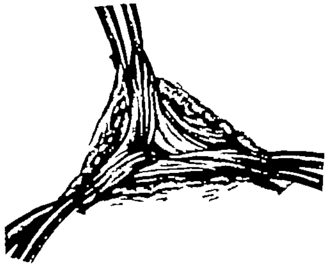
Injection of local anaesthetic

With the patient anaesthetized and in the lithotomy position the area is carefully cleaned and prepared. With a finger in the anal canal as a guide a No 20 2-inch needle on a syringe is passed from a central puncture into each ischio-rectal fossa in turn, and the anaesthetic-adrenaline solution injected (8 ml each side) Further small subcutaneous injections are given as indicated in the position of the three haemorrhoids.

Eversion of the anal canal

)
Dunhill forceps are placed on the skin at the anal verge in the left lateral, right anterior and right posterior positions. If skin tags are present, a wider bite is taken to include them. The forceps are pulled gently in a radial direction, thus beginning the eversion of the anal canal, and the lower poles of the internal haemorrhoids are displayed.

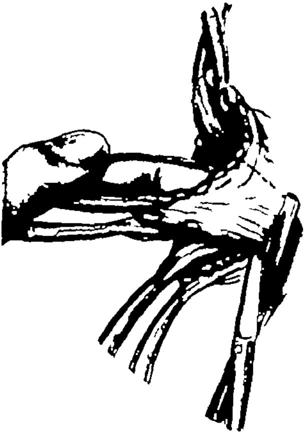
The triangle of exposure

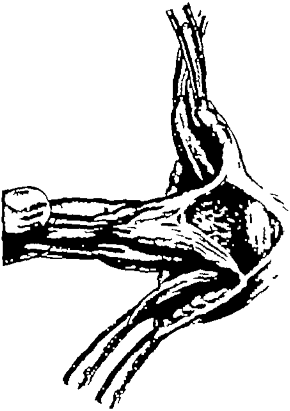


3
The haemorrhoids are pulled further down with non-toothed dissecting forceps and a second Dunhill forceps applied to the pedicle of each one. These when pulled radially as before should be just taut but without tension. Correct exposure is shown by the appearance of a triangle, consisting of little folds of mucous membrane, with the haemorrhoids themselves at the three angles. Any secondary haemorrhoids are taken with another pair of forceps into the main positions.

Start of the dissection

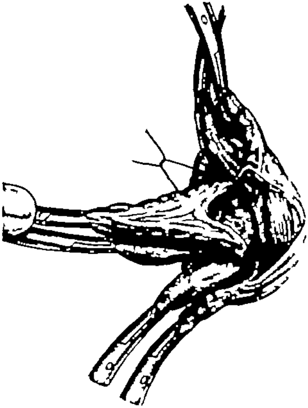
4 The haemorrhoids are dissected in turn and it is convenient to start with the left lateral The others are still held out by an assistant. The two forceps are held in the palm of the left hand, with the left forefinger in the anal canal pressing outwards. One blade of a pair of blunt-nosed scissors is placed in the groove between the haemorrhoid and the skin tag the other blade outside the skin tag and a cut is made. A second cut is made similarly on the other side of the forceps.





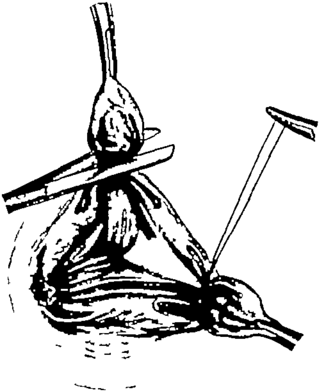
Further dissection

5 Dissection is continued with the scissors, but directed now towards the left forefinger in the anal canal. The circular fibres of the internal sphincter are found and the lower border of this muscle is cleaned and defined by dissection. The haemorrhoid should not be dissected up beyond this point.



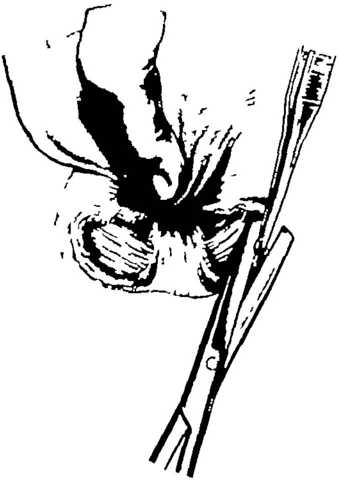
Definition of pedicle and ligation

By further small cuts with the scissors through the skin of the anal canal the pedicle is defined. A little snip in the mucosa on each side may also be necessary to define the pedicle which are then ligated tightly with the knot on the lumen. Strong hollow-wove silk may be used for this, or alternatively catgut after transfixion of the pedicle. The pedicle forceps are removed as the knot is tied, and used for holding the ligature.



Procedure for remaining haemorrhoids

7 The other two haemorrhoids are dissected and ligated in the same way When all three have been dealt with, the tissue beyond the ligature is cut off allowing about ¼ inch of tissue between the cut and the ligature so that the latter cannot slip The ligatures are then cut, also about ¼ inch long



Trimming of wounds

8 By means of a gauze swab pushed gently into the anus, the pedicles are now returned inside the anal canal. While an assistant helps by holding the gauze and skin, the wounds are trimmed to remove excess folds and tags of skin and obtain three flat even wounds for external drainage

Final appearance, dressing

9 A short length of Paul's tubing with a wick of gauze within it is inserted into the anus, for removal the next morning. Flat dressings of gauze soaked in Bradosol 1 in 2 000 are then placed on each side of this over the anus and the wounds, and covered with a pad of cotton-wool or gamgee. A T-bandage is applied to maintain firm pressure

POST-OPERATIVE CARE AND COMPLICATIONS

The dressings are left undisturbed till the next morning, but after that they are changed twice daily At each dressing the patient should have a warm bath, and on return to bed the wound is thoroughly irrigated with hydrogen peroxide followed by Bradosol, 1 in 2 000 A gauze dressing moistened in the same solution is placed over the wounds. Cotton-wool is applied and the T-bandage adjusted.

On the evening of the day after operation, liquid paraffin half an ounce, is given, and a similar dose of paraffin emulsion twice during the next day with a dose of some stronger aperient also if the patient is habitually constipated. The bowels usually act the following morning, and a small oil enema will make this first action easier The bowel action is kept regular and the motions soft thereafter with medicine as necessary and a bath, irrigation and dressing should follow each bowel action.

A finger or small smooth dilator should be passed daily from the sixth day until the wounds are finally healed, and the paraffin should be reduced and finally stopped when the bowels are acting more normally and the wounds nearly healed and painless.

Retention of urine

This usually responds to simple measures such as allowing the patient out of bed, and perhaps aided by the intramuscular injection of Carbachol *B.P* (0 25–0 5 mg.) Catheterization will be necessary if these measures fail, but normal micturition is almost always re-established within a day or two of operation.

Reactionary haemorrhage

Haemorrhage from the pedicle is very rare Bleeding may occur from a small vessel in the external wound and can nearly always be stopped by local application of adrenaline and a few minutes pressure if this fails the vessel must be ligated.

Secondary haemorrhage

This occurs in 1–2 per cent of cases usually on the sixth or seventh post-operative day A considerable amount of blood may be lost, necessitating transfusion as well as measures to arrest the bleeding

A large proctoscope is passed and blood and clots washed out of the rectum. Dry gauze is then wrapped round a 6-inch length of rubber tubing to form a cocoon-like swelling, and this is passed into the rectum through the proctoscope, which is then withdrawn. A little traction on the tube sufficient to arrest the bleeding can be achieved by wrapping more gauze between the anus and a safety pin passed through the tube 2 inches from the anal verge. The tube and gauze are left in place for 48 hours and are then gently removed. Further after-care is continued as before.

Sub scar fistula

It may sometimes happen that the superficial parts of one wound fall into opposition and heal together too quickly thus leaving an infected pocket or fistula deep to the scar

The wound must be laid open again to obtain healing

[The illustrations for this Chapter on Haemorrhoidectomy were drawn by Mr R. N Lane]

Bibliography

Goligher J C., Leacock, A. G and Broasy J -J (1955). *Brit. J Surg.*, **43**, 57
Milligan, E. T C. and Morgan, C. N (1934). *Lancet*, **2**, 1151 1218
— — Jones, L. E., and Officer R. (1937) *Ibid.*, **2**, 1119

FISTULA-IN-ANO

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PRE-OPERATIVE

Indications

Spontaneous healing of anal fistulas is very rare. Further neglected fistulas may cause repeated abscesses and considerable ill-health, and malignant disease may eventually originate in a long-standing fistula. Operation should therefore be advised unless there are definite contra-indications.

Special contra-indications

An anal fistula is sometimes associated with *active pulmonary tuberculosis* and a radiological examination of the chest should be a routine part of pre-operative investigation. The pulmonary disease must be controlled before the fistula is operated upon.

Any *diarrhoea* needs investigation before undertaking an operation for fistula. *Ulcerative colitis* and *Crohn's disease* may give rise to fistulas, and operations on the latter are usually unwise (and often unsuccessful) until the associated disease has been dealt with.

The presence of a carcinoma in the lower bowel must also be excluded by sigmoidoscopy before undertaking any operation on the anal region.

Pre-operative preparation

The lower bowel should be emptied by an enema the night before operation, and a rectal washout given on the morning of operation. The anal region should be widely shaved.

Sterilization of the bowel with sulphonamides or antibiotics is not necessary as a routine measure.

Pre-operative examination

Before starting the operation, the whole anal region should be carefully palpated. With an index finger in the rectum and thumb outside, the induration of a fistulous track can usually be clearly felt, and the probable direction and course of the track estimated. A proctoscope should be passed to detect any anal abnormality and sometimes the internal opening may be seen.

Anaesthesia

General anaesthesia is necessary for all except the most superficial fistulas. Full relaxation should be avoided, as there should be sufficient tone in the muscles to enable the operator to palpate the main parts of the anal sphincters particularly the ano-rectal ring.

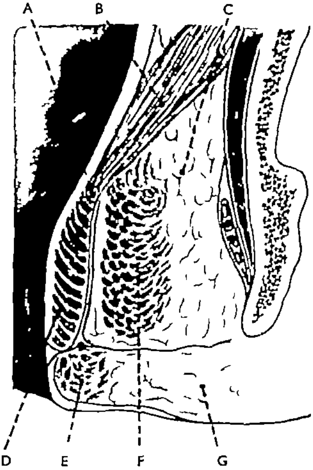
Position of patient

The patient should be in the lithotomy position, with the buttocks pulled down over the end of the table.

THE OPERATION

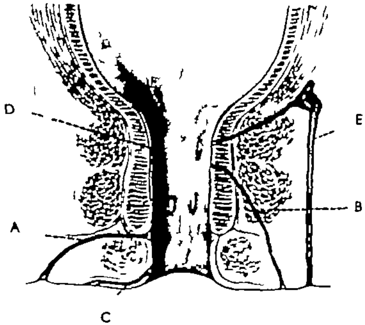
Anatomy

The essential anatomy of the anal region is shown in this diagram. Note that the ischio-rectal fossa is a pyramidal space, the apex of which is above the ano-rectal ring The ano-rectal ring marks the junction of rectum and anus and is formed by the pubo-rectalis fibres of levator ani passing round the bowel and blending with the external sphincter This muscle ring is essential for continence but the other sphincter muscles may be cut with little interference with normal control. The illustration shows (A) ano-rectal ring (B) levator ani (C) ischio-rectal fossa (D) internal sphincter (E) subcutaneous external sphincter (F) other parts of external sphincter (G) perianal space.



Types of fistula

2 With few exceptions, all fistulas follow one of the patterns shown in this diagram. Seventy-five per cent are of the low anal type (A) and about 15 per cent of the high anal type (B) Subcutaneous (C) and submucous (D) fistulas together form about 5 per cent, and ischio-rectal (ano-rectal) fistulas (E) another 5 per cent. Very rarely is a fistula encountered with an opening into the rectum above the ano-rectal ring (pelvi-rectal fistula)

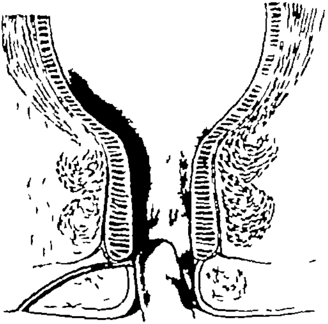


LOW ANAL FISTULA

Insertion of probe-pointed director

3 A probe-pointed director is passed from the external opening along the track until its tip emerges into the anal canal through the internal opening It is helpful to have a finger palpating on to the point of the director thus steadying the anus, but the director must be worked gently along the track and should never be forced through the tissues.

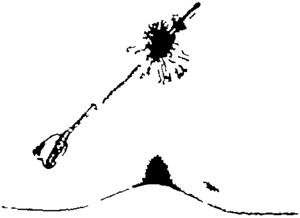
A finger passed into the anus checks the level of the internal opening in relation to the ano-rectal ring to ensure that division of the muscle superficial to the director will not lead to incontinence



Exit of director through the anus

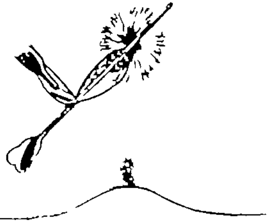
4 Once right through the track the tip of the director is angled towards the operator and is then pushed on to the outside of the anus.

A curved director (see previous illustration) is particularly useful when dealing with rather higher fistulas, or those with a more tortuous track



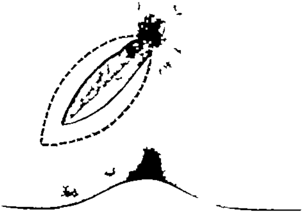
Incision over the director and curettage of granulation tissue

The track is laid open by cutting on to the groove in the director which is then removed. The edges of the wound are held apart, and the granulation tissue curetted away. Search is made by looking, feeling and probing for any other track opening out of the main one, and if such a track is found it is also laid open.



Extension of the wound

The wound is extended outwards for a short distance, and the edges trimmed away so that a shallow open wound can be obtained.

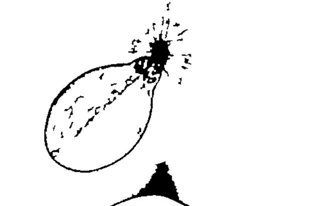


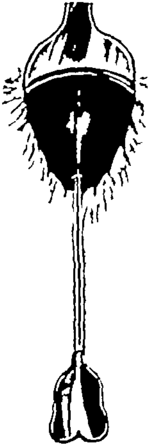
Healing of the wound

Such a wound may appear unnecessarily large, but experience has shown that the healing of anal wounds is better and free from complications when there is good external drainage.

A flat gauze dressing moistened with eusol or Bradosol (1 : 2 000) is placed over the wound, covered with a cotton-wool pad and held in place with a T-bandage.

Subcutaneous and high anal fistulae are dealt with in a similar way. The size and shape of the external wound varies according to the length and direction of the track and the depth of the internal opening, the surgeon always attempting to get a shallow shelving wound.

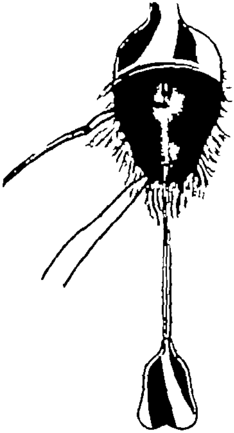




SUBMUCOUS FISTULA

Insertion of Sims' speculum probing the fistula

8 A small Sims speculum is passed into the anal canal and held by an assistant. The director is passed into the lower opening of the fistula, along the track, and its point is passed back into the rectum through the upper opening or may be forced through the mucosa at the upper end of the track if no upper opening exists.



Threading of the seton

9 A fine malleable probe with a seton threaded in the eye is passed along the groove in the director and in this way a strong thread or silk ligature is passed along the track. A second ligature is passed in a similar way

Ligation of the mucosa

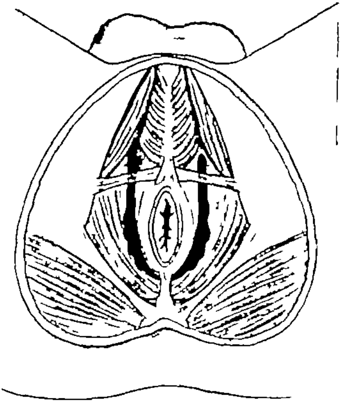
0 The two ligatures are tied as far laterally as possible and very tight, so as to strangulate the mucosa between them When this necroses and the ligatures fall off the fistula is effectively laid open.

If such a fistula is laid open in one stage with a knife, haemorrhage may be brisk and difficult to control. The above method is *satisfactory but alternative methods some-times possible are* (1) division between artery forceps with subsequent ligation and (2) division with a diathermy needle.

ISCHIO-RECTAL FISTULA

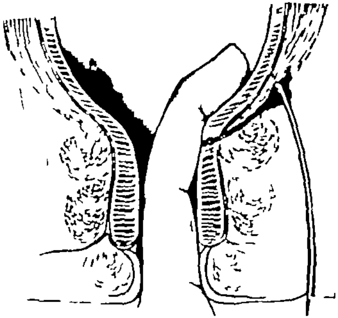
Course of the main track

11 The main track of an ischio-rectal fistula follows the roof of the ischio-rectal fossa that is to say it lies on the under-surface of the pubo-rectalis muscle The track is there-fore of horse-shoe shape if both sides are involved with the anterior extension on each side passing deep to the transverse perineal muscle The communication with the anal canal is most frequently in the midline posteriorly but not invariably so The track leading to the external opening on the skin is not shown on this diagram, but is usually a vertical track which may descend from any part of the main one



Insertion of probe to determine the main track

12 If a probe be passed into the external opening it will enter deeply *parallel* to the anal canal and its tip can often be palpated through the rectal wall at a level above the ano-rectal ring. It must never be forced through here as the real internal opening is nearly always below the ano-rectal ring still following the under-surface of the pubo-rectalis.

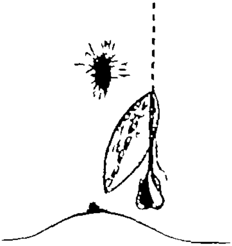


First incision

13 The director is passed up the vertical track, and is held with the groove posteriorly by an assistant. The left index finger steadies and protects the rectum. A scalpel is slid up the groove in the director and cuts out backwards towards the coccyx, thus laying open the posterior part of the track on that side

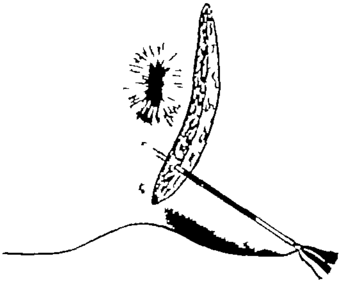
Exposure of anterior extension

14 The edges of the wound are held apart and the main bleeding points secured. The anterior extension is sought in the depths of the wound. The director is passed along that track, which is then laid open by dividing the overlying tissues. The posterior part of the perineal membrane and contained muscles may need to be divided in laying open this part.



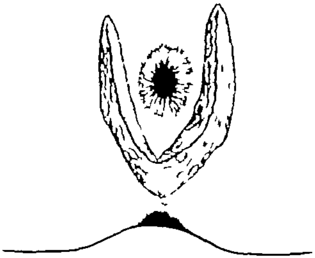
Extension of track to opposite ischio-rectal fossa

Attention is now turned to the posterior end of the wound, where an extension to the opposite ischio-rectal fossa is sought in the depths of the wound. Probing must be gentle, but must seek particularly where there are visible granulations or palpable induration.



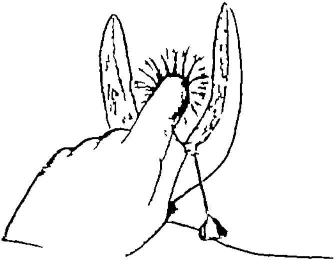
Exposure of extension to opposite ischio-rectal fossa

6 If an extension of the track to the opposite ischio-rectal fossa is found, it is laid open for its full length by the division of overlying tissues as on the other side. The laying open of these deep tracks must be carried out carefully and thoroughly and many large vessels in the fat may require ligation or coagulation.



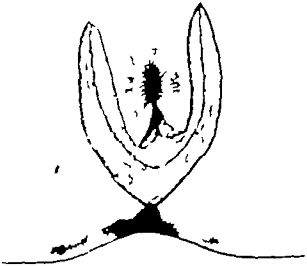
Search for internal opening

17 A search is now made for an internal opening, and the area near the midline posteriorly should be searched first as this is the most frequent site The communicating track is often oblique (see Illustration 12) and an angled director may be necessary to find it. When found, one must first ensure by careful palpation, and inspection through a proctoscope that the internal opening is below the ano-rectal ring



Division of sphincter muscles

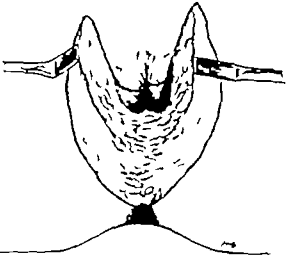
18 If it is certain that the internal opening is below the ano-rectal ring the contained muscles are divided by cutting on to the probe If there is doubt, the superficial muscles may be divided and a seton passed through the deeper part and knotted loosely (see Illustration 4 Part IV page 8) for division at a later date after further examination



Extension and trimming of the wound

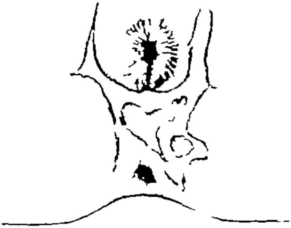
19 The wound is trimmed and enlarged by excising some skin edges and redundant fat, and the whole wound fashioned so as to shelve as shallowly as possible All granulation tissue is meticulously curetted away and a careful search should ensure that no section of track has been overlooked.

Flat gauze dressings moistened with eusol or Bradosol (1 2 000) are applied lightly to keep the edges of the wound apart, covered with a large cotton-wool pad and held in place with a T-bandage.



Healed appearance and sphincteric function

20 Many weeks later the wound will be almost healed, the final scar being much smaller than the former wound, and the anal appearance may not be grossly altered Sphincteric function is usually excellent.



SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

The post-operative care of anal wounds and the attention needed to regulate the bowel action has been fully ˇ ɔed m the Chapter on Haemorrhoidectomy (Part IV page 22) The same regime should be followed in the ıre of the small and superficial wounds following an operation for fistula.

Larger wounds, and particularly those following operations on ischio-rectal fistulas require rather more detailed ...ıtion. The first few dressings will be painful, and a light general anaesthetic may be necessary to allow them be properly applied, or alternatively an analgesic drug may be given. The bowels should be encouraged to act the third or fourth post-operative day and thereafter kept regular and the motions soft with suitable medicines a full diet.

After the first few days a bath, irrigation and dressing should follow each bowel action, and a similar sequence ould be adopted each evening Two experienced nurses are needed for the dressings, and good lighting is essential. After a thorough irrigation, the moist flat gauze is placed gently into the depths of the wound by one nurse while he other holds the wound edges apart.

There is some tendency for large deep wounds to form pockets which delay healing it is therefore advisable ɔ examine them carefully once weekly throughout the period of healing, with the patient in the lithotomy ... on in the operating theatre. The first few such examinations should be carried out under anaesthesia. In this ..y the wound can be trimmed as necessary during the healing process, and any pockets, or tracks that have been ɔverlooked can be laid open Final healing may take 6–12 weeks, and patience on the part of both surgeon and ...ıt is necessary

In those cases in which division of the greater part of the anal sphincter has been necessary the power and ... u of the remaining portion may be improved by active sphincter exercises throughout the period of healing, l the patient should be instructed to carry them out.

[The illustrations in this Chapter on Fistula-in-Ano were drawn by Mr F Price]

Reference

Milligan, E. T C., Naunton Morgan, C., Lloyd-Davies, O V., and Thompson, H. R. (1948) "Fistula in Ano" *British Surgical Practice*, Vol. 4 p. 102. London Butterworth.

ISCHIO-RECTAL ABSCESS

H. E. Lockhart-Mummery, M.B., M.Chir., F.R.C.S.

Surgeon, St. Mark's Hospital, London

PRE-OPERATIVE

Indications

Infection in an ischio-rectal fossa may spread rapidly and extensively in the loose fat that fills these fossae and any abscess should therefore be opened without delay. Diagnosis is often difficult in the early stages when the abscess is small; examination under anaesthesia in the lithotomy position may be necessary before the presence of a suspected abscess can be confirmed.

Chemotherapy and antibiotics are of little value in the treatment of an ischio-rectal abscess, and may be harmful if their use leads to delay in surgery.

There are no contra-indications.

Pre-operative preparation

If the patient's pain and tenderness allow, the rectum should be emptied by an enema before operation. The anal region should be shaved, but this may need to be deferred until the patient is anaesthetized.

Pre-operative examination

Before commencing the operation, careful examination and assessment are advisable. An index finger is passed into the rectum, and by careful palpation between this finger and a thumb outside, the extent of the abscess can be determined fairly accurately. Moreover, the anatomy of the abscess can in this way be carefully assessed, and one can make sure whether the abscess to be opened is really in the ischio-rectal fossa, or is supra-levator or submucous, for in the latter cases a different approach would be necessary.

A proctoscope should be passed to examine the condition of the rectal mucosa and to detect the presence of any anal pathology, such as haemorrhoids, or a visible internal opening of the abscess. It is also advisable to pass a sigmoidoscope in any rectal case before undertaking surgery.

Anaesthesia

General anaesthesia is satisfactory, but sufficient depth to give sphincter relaxation is not required.

Position of patient

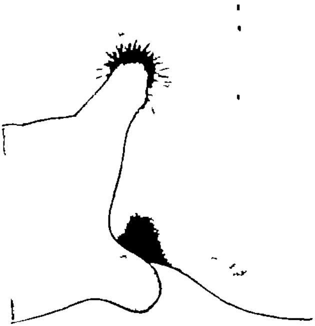
The patient should be in the lithotomy position with the buttocks pulled down over the end of the operating table, the lower flap of which should be removed.

THE OPERATION

First incision

1 With the patient anaesthetized and in the lithotomy position, careful palpation of the swelling is carried out with the index finger of one hand in the rectum and the other hand over the external swelling The rectum and anal canal should be inspected with a proctoscope.

An index finger steadies the swelling from inside the rectum. A straight incision is made over the most prominent part of the abscess, usually about 1½ inches from the anal verge. This incision is short to begin with, and is slowly deepened until pus is obtained.

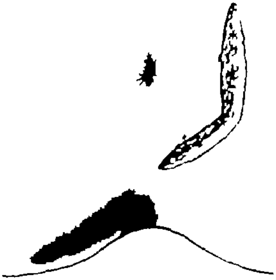


Exploring the abscess cavity

2 Pus is allowed to escape, and a specimen is taken for bacteriological examination. A finger is then passed into the abscess cavity loculi gently broken down, and the extent and direction of the cavity explored.

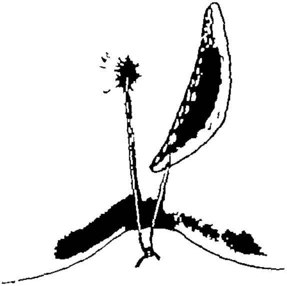
Extension of incision

3 The incision is extended over the main prolongation of the abscess cavity and any irregular and overhanging skin edges are then excised to allow free drainage Wide excision of skin edges is unnecessary at this stage
The abscess most commonly extends towards the posterior midline requiring a posteromedial extension of the incision as illustrated



Final wound communicating track marked

4 Should there be an *obvious* communication with the anal canal a seton may be passed through and loosely tied in order to mark it for a later stage. The relationship of such a track to the anal muscles may be obscured by the oedema and it is usually wiser not to attempt to lay it open in the acute stage
A flat gauze dressing moistened with eusol or Bradosol (1 2 000) is applied, covered with a large cotton wool pad and held in place with a T-bandage



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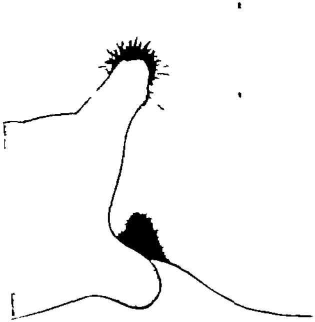

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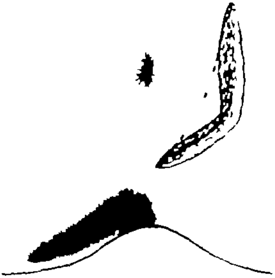

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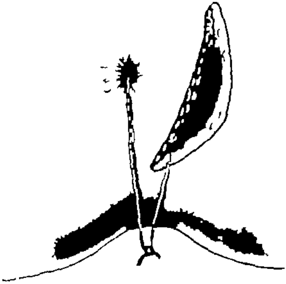

THE OPERATION

First incision

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An index finger steadies the swelling from inside the rectum. A straight incision is made over the most prominent part of the abscess, usually about $1\frac{1}{2}$ inches from the anal verge. This incision is short to begin with, and is slowly deepened until pus is obtained.

Exploring the abscess cavity

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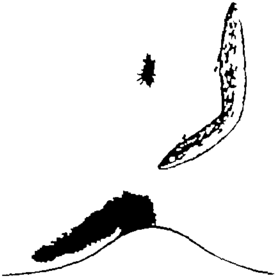

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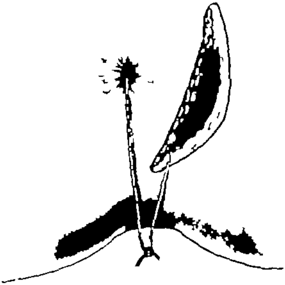

POST-OPERATIVE CARE AND COMPLICATIONS

The dressing is changed the next morning, the wound is irrigated with peroxide followed by Bradosol (1 in 2 000) and a fresh dressing of gauze moistened with the same solution is gently placed over the wound keeping the edges apart. The wound should not be packed, and ribbon gauze should never be used. On the second day the patient may take a bath and thereafter bathe twice daily

The bowels should be encouraged to act normally from the second or third day by a full diet and suitable mild aperients. A little olive oil run into the rectum will make the first action easier A bath, wound irrigation and dressing should follow each bowel action.

After 5–8 days, the patient should again be anaesthetized, placed in the lithotomy position and the wound carefully explored. Particular search should be made for an internal opening into the anal canal (if not previously marked) which, if found, must be laid open.

Extensions in the ischio-rectal fossae which may have been overlooked at the first operation are also sought, and the wound is extended as necessary to lay these open skin being now excised where necessary in order to fashion a wound which will heal by granulation without pocketing

After-care and dressings are continued as before, and are further described in the Chapter on Fistula-in-Ano (Part IV page 82)

A *persistent fistula* or *recurrent abscess* following drainage of an ischio-rectal abscess nearly always signifies that a track or communication with the anal canal has been overlooked or inadequately laid open.

[*The illustrations for this Chapter on Ischio-Rectal Abscess were drawn by Mr F Price*]

Bibliography

Gabriel, M. B (1949). *The Principles and Practice of Rectal Surgery* 4th ed. London Lewis.
Morgan, C. N (1949). "The Surgical Anatomy of the Ischio-rectal Space." *Proc. R. Soc. Med.*, **42**, 180

ANO-RECTAL ATRESIA
WITH ASSOCIATED FISTULAS

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PRE-OPERATIVE

GENERAL

Classification

There is no completely satisfactory classification of these congenital anomalies of the ano-rectal region, that suggested by Ladd and Gross (1934) being the one most commonly used. Type 1. Congenital stenosis of the anal canal (rare). Treatment is by regular repeated dilatation until there is no tendency for the stenosis to recur. Type 2. Membranous occlusion of the anus. Type 3. Imperforation or absence of the anus, the rectum ending blindly. Type 4. A normal anus and anal canal forms a small blind distal segment while the rectum ends blindly at varying distances from the anal canal.

In a large series of cases Gross (1953) found that type 1 cases accounted for 5·7 per cent, type 2 for 2·8 per cent, type 3 for 87·4 per cent and type 4 for 4·1 per cent.

Fistula into other organs or displacement of the anal orifice

The rectum may communicate with other organs or open on to the surface at an abnormal site.

The abnormal orifice is controlled in some instances by a sphincter mechanism and the lesion is therefore more in the nature of an ectopic anus (Browne). In addition the so-called perineal fistula may indicate the underlying normally functioning anus to which the term "covered anus" has been applied by Browne.

It is not sufficient to make the diagnosis of imperforate anus or ano-rectal atresia. The type of defect, the level to which the blind end of the rectum extends and the presence or absence of fistula into the urinary tract or vagina must be established before appropriate measures can be taken for the relief of the condition.

Pre-operative diagnosis of the type of anomaly

Examination of the perineum and of the anus and lower rectum, if present, is followed by examination of the urine for meconium and by radiography. Wangensteen and Rice (1930) used the plain radiograph following the holding of the baby for some minutes in the vertically head down position in order that air could rise to the highest point through the viscid meconium and so delineate the cap of the lower end of the rectal segment. This method is only reliable after the baby is 24 hours old.

Association with other congenital defects

A careful examination should be made to exclude other anomalies, particularly those which in themselves require urgent surgical treatment, such as oesophageal atresia, which is found in about 4 per cent of cases.

Pre-operative preparation

A catheter is passed into the stomach, which is aspirated, and the tube is left *in situ*. This measure also serves to exclude oesophageal atresia.

In types 3 and 4 it is advisable to insert a cannula or polythene tube into a vein in order that blood may be given when required and blood should be cross-matched in readiness.

Anaesthesia

Opinions differ about the need for anaesthesia in these small babies. Some anaesthetists favour the use of relaxants combined with the administration of oxygen and minimal sedation while others prefer general anaesthesia with cyclopropane and oxygen or open ether with or without a relaxant. Whatever the technique employed it is important that these babies should not be given large doses of a toxic anaesthetic agent.

Position of the patient

For the abdomino-perineal and perineal operations the baby may be placed on a special table of the Stephens type. If this is not available the baby may be positioned with sandbags and the legs fixed in position with adhesive plaster

OPERATION FOR MEMBRANOUS OCCLUSION OF THE ANUS (Type 2)

(Not illustrated)

With the baby in the lithotomy position the perineum is prepared and the membrane is incised by a cruciate incision. The opening is then dilated with dilators or by the little finger Complete excision of the membrane is not possible as a rule because the escape of meconium makes it impossible to do this under clear vision. Dilatation is carried out daily at first and continued until healing is complete and there is no tendency to contraction of the anus. It must be emphasized that these cases are uncommon

PERINEAL PROCTOPLASTY

Indications

Cases of type 3 ano-rectal atresia in which (1) a raised triangle of skin is present, (2) it is established that the blind rectal loop extends to within 1·5 cm. of the perineal skin and (3) when no communication with the urinary tract exists, constitute indications for this procedure

Special contra-indications

Contra-indication exists when there is associated fistula into the urethra, bladder or vagina when the rectal loop *ends more than 1·5 cm. from the perineal skin and in types of ano-rectal atresia other than type 3*

Position of the patient

The baby is placed in the lithotomy position and a catheter is inserted per urethram.

ABDOMINO-PERINEAL PROCTOPLASTY

This one-stage procedure was introduced by Rhoads, Pipes and Randall (1948) and has been reported favourably by Norris, Brophy and Brayton (1949) by Potts, Riker and De Boer (1954) and by Gross (1953)

Indications

Abdomino-perineal proctoplasty is indicated (1) for the immediate treatment of cases of type 3 ano-rectal atresia in which the rectum ends more than 1 5 cm. from the perineal skin (2) for cases of ano-rectal atresia in which there is a fistula between the rectum and the urethra or bladder (similarly in type 3 cases in which the presence of such a fistula cannot be excluded pre-operatively) (3) for the definitive repair of cases as in 1 and 2 above when the obstruction has been relieved by colostomy (4) type 4 cases which are treated by a modification of this procedure.

Special contra-indications

Cases which are suitable for correction by perineal proctoplasty should not be submitted to the combined operation.

Pre-operative preparation

The stomach is emptied by a tube which is left in place. An intravenous drip is set up and blood is matched in readiness.

OPERATIONS FOR RECTO-VAGINAL FISTULA

PERINEAL REPAIR OF ANO-RECTAL ATRESIA WITH RECTO-VAGINAL FISTULA (Potts Riker and De Boer 1954)

In many cases the bowel empties normally through this type of fistula so that operation is not necessary in the newly born baby

When the rectum opens in the lower vagina or at the fossa navicularis the orifice is often controlled by an efficient sphincter mechanism Browne has suggested that these are cases of ectopic anus and that the ideal treatment is to get the anus to function adequately where it lies. He advises enlargement of the orifice by a single backward cut followed by regular dilatation. Initially following this the vaginal and anal orifices lie closely apposed without intervening skin but with further growth they tend to separate to some extent.

Gross advises a procedure similar to that described under perineal proctoplasty above. The rectum is freed so that the fistula can be identified and divided the vaginal end being closed by suture The perineal proctoplasty is then carried out in the ordinary way Any delay in the healing of the vertical incision is followed by the forward displacement of the anus and Potts, Riker and De Boer have advocated a different method which will be described

OPERATION FOR TYPE 4 ANO-RECTAL ATRESIA

(Not illustrated)

These cases are the most difficult to treat because the site of the obstruction may be difficult to reach both from the perineum and from the abdomen. It will be necessary to mobilize the rectum as described in abdomino-perineal proctoplasty The anal segment may be opened proximally and everted. The rectum is then brought down and anastomosed to the anal canal In this type it is probably wise to make a colostomy and to defer the formal repair to a later age.

COLOSTOMY IN ANO-RECTAL ATRESIA

Indications

A colostomy may be performed in (1) type 4 lesions for repair later (2) type 3 lesions when the rectal pouch ends more than 1 5 cm from the perineum, when recto-urethral fistula has been excluded when surgeon and anaesthetist have little experience of the newborn a loop transverse colostomy is life-saving When there is a fistula into the urinary passages even a defunctioning colostomy would not prevent urinary tract infection and direct closure of the fistula is required

Special contra-indications

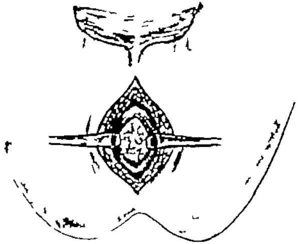
(1) Type 1 and 2 lesions. (2) Type 3 lesions without urinary fistula in which perineal proctoplasty is indicated. (3) Type 3 cases with recto-urinary fistula in which the blind rectal loop is more than 1·5 cm. from the perineum. In such cases the fistula must be closed from the abdomen and the surgeon may then make a colostomy leaving the proctoplasty to the age of 1½–2 years

THE OPERATIONS

PERINEAL PROCTOPLASTY

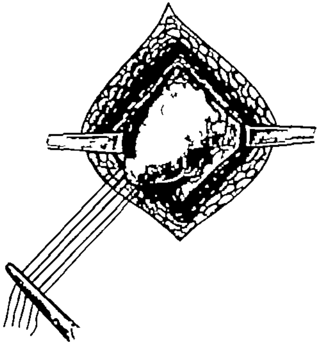
Incision

1 An antero-posterior incision is made in the midline of the perineum from the base of the scrotum to the tip of the coccyx. It splits the external sphincter the two halves of which are retracted laterally This exposes the deep perineal fat in which the rectal loop lies.



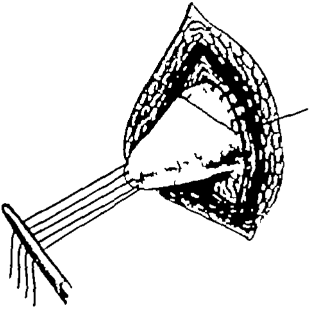
Mobilization of rectal loop

2 The blind rectal loop is identified and sutures are inserted into its apex to facilitate its further manipulation. Dissection is continued to mobilize the rectal loop on all sides so that it can be brought to the perineum without tension



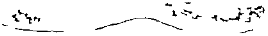
Suture of rectal loop

3 The rectal loop is brought out through the retracted halves of the external sphincter and is fixed in position by interrupted sutures of fine silk uniting its outer coats to the subcutaneous tissue on all sides.



Closure

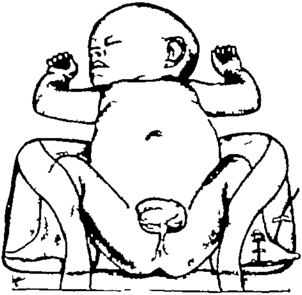
4 The portions of the skin incision anterior and posterior to the rectum are sutured. The rectum is opened, its contents removed by suction and the circumference of the mucous membrane is sutured to the skin edges with interrupted stitches of fine chromic catgut. The anus so formed should be 60 per cent larger than normal to allow for any subsequent scarring and contraction.



ABDOMINO-PERINEAL PROCTOPLASTY

Position

5 Free access is necessary to the abdomen and to the perineum. The hips are flexed, abducted and externally rotated and are then fixed in that position to sandbags on which they lie. Before the anaesthetic is given the skin of the perineum is stimulated and the centre of the external sphincter is marked for later identification.

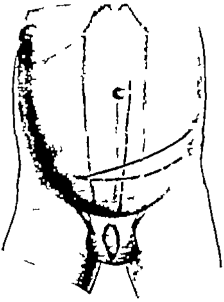


ABDOMINAL PART OF THE OPERATION

Exposure

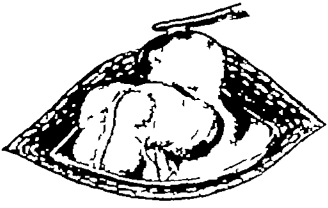
6 A generous exposure is necessary. It may be obtained by (1) a transverse suprapubic incision dividing both rectus muscles (2) an incision similar to (1) but continued laterally on the left side as a muscle cutting incision (3) a muscle-displacing left paramedian incision from the pubis to at least 2 cm. above the umbilicus.

A catheter is passed per urethram and palpation verifies that it has reached the bladder. The catheter is passed at this stage in preference because if passed earlier it may enter the fistula and so the rectum. For this reason Gross advises that the bladder should be opened, the catheter passed retrogradely from above and the bladder drained suprapubically.



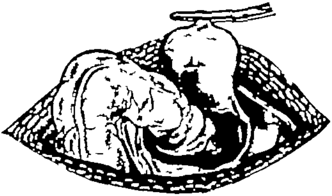
Mobilization of pelvic structures

7 With the surgeon standing on the left side of the patient, the abdomen is opened, the urachus and the umbilical arteries are divided and the bladder is displaced forwards over the lower edge of the transverse incision using the urachus for gentle traction. This brings the pelvic structures into a more accessible position and facilitates the dissection of the rectal pouch and fistula.



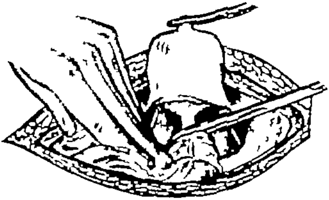
Division of peritoneum

8 If distension of the rectum and sigmoid handicaps the exposure they are emptied by suction through a wide-bore needle and the small puncture is closed by a single stitch. The passage of further meconium into the rectum from above is prevented by the gentle application of an occlusion clamp to the upper sigmoid. The rectum is lifted upwards while the peritoneum on its lateral and anterior aspects is divided.



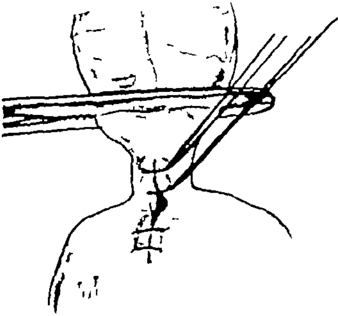
Further detachment

9 Both ureters are identified. The rectum is freed from its attachments laterally in the pelvis and posteriorly from the hollow of the sacrum.



Identification of fistula

10 The bladder is retracted farther forwards and upwards while the rectum is displaced posteriorly and the dissection is continued between the two organs until the fistula is identified at the bladder base or entering the prostatic urethra. A light ductus or similar clamp is applied to the lower end of the rectum just above the fistula.



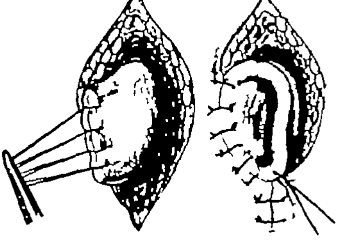
Division of fistula

11 If the fistula is of considerable calibre it is divided bit by bit, being closed by suture both on the bladder and rectal aspects as the division continues. If of small calibre and with the assurance of the urethral catheter as a guide it may be divided between ligatures. The rectal ligature or sutures are left long and held in forceps.

PERINEAL PART OF THE OPERATION

Exteriorization of rectal sutures

12 A small midline incision is made, centred over the previously marked site of the external sphincter. The muscle is identified and is stretched gently with forceps. Keeping close to the hollow of the sacrum a curved artery forceps is inserted through the centre of the sphincter and the rectal sutures are grasped by it and brought out on to the perineum.

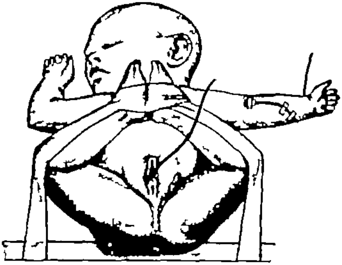


Rectal sutures

13 The rectum is brought down so that it can be sutured to the skin without tension but redundant bowel should be avoided. If the rectal loop is not long enough it may be mobilized by division of the inferior haemorrhoidal artery. The rectal pouch is opened and its mucosa is sutured circumferentially to the edges of the skin wound with interrupted sutures.

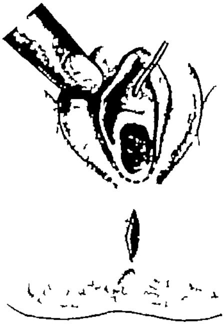
The pelvic peritoneum is closed around the rectum and the abdominal wound is closed in layers.

PERINEAL REPAIR WITH RECTO-VAGINAL FISTULA



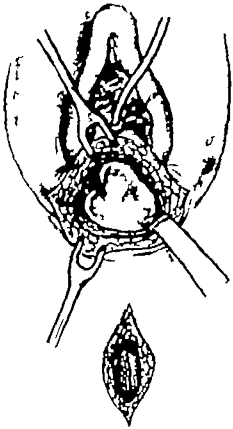
Position

14 The baby is placed in the lithotomy position or with the hips flexed, abducted and rotated so that the legs lie over the abdomen with the soles of the feet in contact in the midline. The position is maintained by the use of adhesive strapping Before the anaesthetic is begun the site of the external sphincter is identified by stimulation of the perineum and its position is marked. A catheter is inserted.



Primary incisions

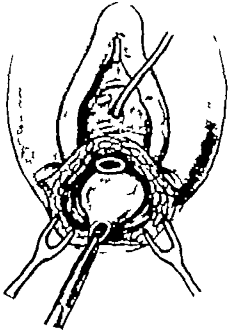
15 A vertical incision is made over the site of the sphincter the fibres of which are exposed and spread gently (see Illustration 12) A curved incision is made transversely just posteriorly to the vagina.



16

Isolation of fistula

The vaginal incision is deepened to expose the surface of the recto-vaginal fistula. Blunt dissection serves to separate the loose tissue on either side and thereafter the fistula is isolated by gently insinuating a curved artery forceps round its deep surface.



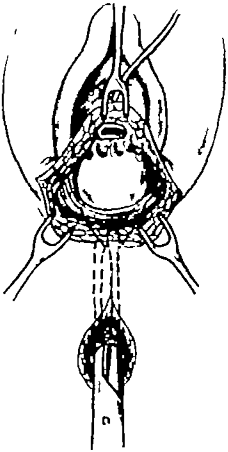
17

Division of fistula

After thorough separation the fistula is divided as close as possible to the vaginal wall. The vaginal end is closed by suture while the rectal end is held gently with tissue forceps and is turned posteriorly

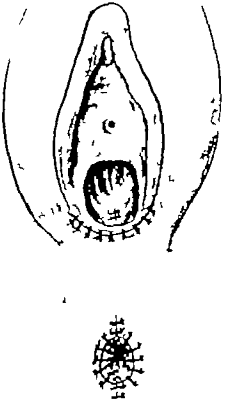
Rectal approximation

18 The rectum is drawn gently posteriorly and with fine scissors is dissected from the vaginal wall anteriorly from the perineal body and from the transversus perinei muscles laterally The separation anteriorly from the vagina should be carried farther proximally than would appear to be necessary in order that there will be adequate length for its transposition without tension. The dissection must not keep too close to the rectal wall in order that sufficient tissue will be left attached to the rectum to safeguard its blood supply
A tissue forceps is passed through the sphincter via the previously made perineal incision and the rectum is brought deep to the perineal body and out on the perineum



Closure

19 The circumference of the cut end of the rectum is sutured to the edges of the perineal skin incision without tension. The anterior incision is then closed and the catheter is removed.



POST-OPERATIVE CARE

PERINEAL PROCTOPLASTY

Should the orifice appear to be too small dilatation of the anus should be begun about 14 days after operation and should be continued as long as the muco-cutaneous junction remains firm

ABDOMINO-PERINEAL PROCTOPLASTY AND PERINEAL REPAIR

The urethral or bladder catheter is retained for 5–7 days. Antibiotic cover is advisable to prevent infection of the perineal wound and urinary tract. Oral feeding is begun on the second day

If the anal orifice appears to be too small dilatation is begun about 2 weeks after the operation and is continued until healing is secure

Difficulty with evacuation may continue for some time as the child does not have normal rectal sensation.

[*The illustrations for this Chapter on Ano-rectal Atresia were drawn by Mr J Wheldon*]

Bibliography

Bacon, H. E., and Sherman, L. F (1952) *Arch. Surg* **64**, 831
Gross, R. E. (1953). *Surgery of Infancy and Childhood*. Philadelphia and London Saunders.
Ladd, W E., and Gross, R. E. (1934). *Amer J Surg.*, **23**, 167
Moore, T C., and Lawrence, E. A. (1952). *Surg Gynec Obstet.*, **95** 281
— — (1952) *Surgery* **32**, 352
Norris, W J., Brophy T W., and Brayton, D (1949) *Surg Gynec. Obstet.*, **88** 623.
Potts, W J., Riker W L., and De Boer A. (1954). *Ann Surg.*, **140** 381
Rhoads, J E., Pipes, R. L., and Randall, J P (1948) *Ann. Surg.*, **127** 552
Santulli, T V (1952) *Surg Gynec. Obstet.*, **95**, 601
Wangensteen, O H., and Rice, C. O (1930). *Ann. Surg.*, **92**, 77

RECTAL PROLAPSE

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PRE-OPERATIVE

Choice of operation

It is important to differentiate between partial prolapse (of mucosa only) and complete prolapse involving full thickness of bowel wall. Major surgical procedures are reserved for the latter type. Procedures for dealing with partial prolapse will be listed later Numerous operations have been advocated for complete prolapse, but pride of place is still given to rectosigmoidectomy as described by Miles (1933) It should, however be pointed out that this operation has been shown to have shortcomings, but a satisfactory alternative has not as yet gained universal acceptance.

Indications

Surgery is indicated for complete rectal prolapse occurring in the adult. The appearance of patulous lax sphincter is no contra indication, as this quickly improves once the prolapse has been dealt with, especially in the intelligent co-operative patient. Secondary proctitis ulceration, metaplasia and new growth make the indications more cogent

Special contra-indications

Prolapse occurring in children, either partial or complete (which is rare) should be treated conservatively

Radical measures should not be undertaken for complete prolapse in those subjects who are unlikely to co-operate with post-operative sphincter exercises—such as the very senile demented, deaf or irascible. Some measure of improvement may be obtained for these if treated on similar lines to cases of partial prolapse.

Where previous birth injuries have led to damage of the pelvic floor and associated prolapse of uterus and vaginal wall, consultation and combined surgery with a gynaecologist are indicated.

Special investigation

Preliminary sigmoidoscopy is essential to exclude any pathology higher in the large bowel

A careful assessment of the sphincters, perineal body and levators should be made by digital examination in the conscious patient after reduction of the prolapse

Pre-operative treatment

Anaemia is corrected by iron or blood transfusion. Colonic antisepsis is achieved with one of the slowly absorbed sulphonamides (phthalylsulphathiazole 10 gr daily in divided doses for 4–5 days) streptomycin 1 g and penicillin 800 000 units Distaquaine Fortified immediately prior to the operation. Colonic lavage is carried out with saline on the morning of the operation taking great care that all the solution is returned. The bladder should be emptied by catheter

Anaesthesia

General anaesthesia of any type is satisfactory A certain degree of hypotension is advantageous, though not essential and where the anaesthetist is conversant with such agents intravenous pethidine or other hypotensive drugs will help especially in the earlier stages of the operation Spinal anaesthesia is contra-indicated as the consequent spasm of the colon makes the handling and suturing difficult.

Position

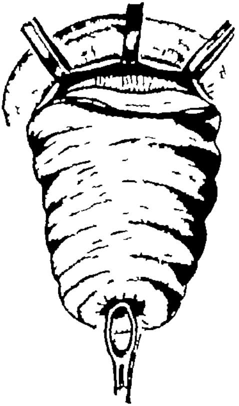
The patient should be arranged in the lithotomy position in which a certain degree of head-down tilt aids in reducing bleeding and helps in control of small bowel which may present in the peritoneal sac anteriorly

THE OPERATION

Circular incision of the outer layer of the prolapse

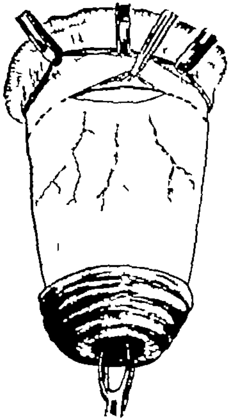
1 The total extent of the prolapse is delivered through the anus and cleansed together with the surrounding buttocks with Cetavlon is dried, and again cleansed with Lysol 1 drachm to the pint of water

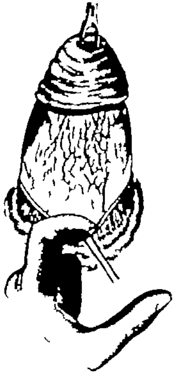
The incision is made ½ inch distal to the anal margin, commencing in front and encircling the prolapse. It divides the mucosa and muscular coats. Bleeding is brisk and controlled by haemostats. Cutting diathermy should not be used as small bowel is sometimes present in the anterior peritoneal sac beneath. Tissue forceps are applied to the cut margin of the anal canal



Identification and opening of the peritoneal sac

2 The outer cuff of the prolapse is peeled down exposing extraperitoneal fat and the peritoneal sac in front. Behind there is no sac but an excess of fat in which run the terminal branches of the superior haemorrhoidal vessels, that is, the pelvic mesocolon. After clipping with haemostats the peritoneal sac is opened widely in the transverse direction at the same level as the original encircling incision If small bowel is seen this is reduced into the pelvis and the head-down tilt of the table increased





Delivery of all excess colon

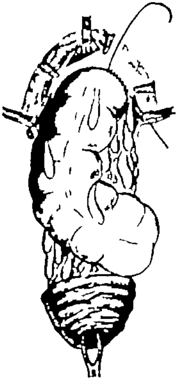
3 All slack colon is gently pulled on and delivered outside There is no difficulty anteriorly but a little blunt dissection with the finger posteriorly helps to equalize the length of the anterior and posterior walls.

Ligation of the vascular pedicle

4 Lifting the colon forwards, the vascular pedicle is dissected from out of its surrounding fat and ligated with No 35 linen thread the fat and smaller vessels are cleaned off the posterior wall at the selected site of severance and suture of the bowel.

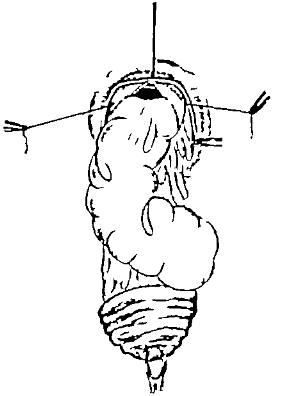
Closure of peritoneal sac

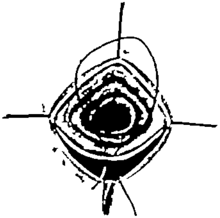
5 The cut margin of peritoneum anteriorly is re-attached to the colon as high as possible by a continuous catgut suture, thus reforming the pouch of Douglas at a higher level. In large prolapses it may be necessary to resect a portion of redundant peritoneum before suturing
It is advisable to take a double bite when suturing the peritoneum and especial care is required to close the corners.



Division of colon

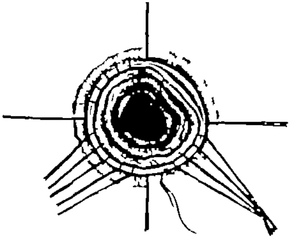
6 The division of the colon is undertaken with scissors, and commences anteriorly about 1 inch distal to the anus. There should be no excess traction at the time of division, and it is wise to place one anterior mattress stay suture to approximate the cut margins of the colon and rectum before proceeding laterally with the section.
The division of the colon should be aimed at being oblique from before back. This tends to correct any inequality in size of lumen lessens the ischaemia of the suture lines, and tends to prevent excessive retraction which is prone to occur especially behind.





Suture of bowel

7 Further stay sutures, right and left, mark the meridian and as the bowel is finally severed a fourth stay suture marks the midline posteriorly (These stay sutures are disposed like the points of a compass, N., S., E., and W.)



Completion of suture line

8 The gaps between the stay sutures are filled in with further interrupted sutures placed accurately so as to approximate all coats of bowel wall but not closer than 2 mm. Non-absorbable sutures of No 40 cotton are used throughout. (A continuous suture should be avoided, as this tends to ischaemia of the margins and secondary stricture formation.) As soon as the sutures are cut short the bowel retracts, and it will be noted that the anal canal and lower rectum has a funnel shape. This is only temporary and disappears as soon as the sphincter tone returns No drainage tube is required, a pad of wool and a T-bandage sufficing

Modifications of standard operation

9 Mattress sutures may be inserted to approximate the two edges of the puborectalis muscles in front of the new rectum (Cohn, 1942) In order to improve rectal sensibility Muir (1954) suggests leaving rather more rectum, making the encircling incision $2\frac{1}{2}$–3 inches distal to the anal margin.

The anus may be encircled with a strand of silver wire (20 s w.g.) as in Thiersch's operation A large bore serum needle is bent to the desired curve and used for threading the wire through. Though usually reserved for the very elderly with partial prolapse and incontinence it can be a useful adjunct to rectosigmoidectomy in cases with poor sphincter tone. It may be done at the time of the major procedure, but it is best performed when time has shown a poor return of function. In women with concomitant uterine procidentia the wire can be extended to encircle the vagina in a figure of eight (Dickson Wright)

ALTERNATIVE PROCEDURES

Alternative operations to sigmoidectomy

Anterior abdominal resection of the rectum (*Muir* 1951) —Greater familiarity with this operation for innocent an malignant conditions of the rectosigmoid has made it a safe way of dealing with redundant colon. Fixation is mor prone to occur in the sacral hollow and the new peritoneal floor can be placed higher

Intra-abdominal repair of the muscular and fascial floor of the pelvis together with posterior displacement of the rectum an excision of redundant peritoneum in the pouch of Douglas —This is the operation devised by Roscoe Graham (1942) and is based upon the recognition of the prolapse as being in fact a sliding perineal hernia

For numerous other alternatives the reader is referred to standard works on proctology

Procedures for partial prolapse

Procedures advocated for partial prolapse include submucous injection of carbonized oil as for haemorrhoids but using rather more solution and more punctures the three ligature operation as for haemorrhoids linea cauterization of the anal canal or Thiersch s operation of encircling the anus with silver wire.

SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

No enemas are allowed. Paraffin is given daily and bowel action encouraged on the fifth post-operative day by mild aperient and glycerine suppositories. Faecal impaction must be guarded against by digital examination.

Sphincter exercises are commenced from the first post-operative day These are similar to post-partum perinea exercises and are best supervised by a physiotherapist 2 or 3 times a day The contractions should be slow steady an maintained for a few seconds at a time In resistant cases assistance can be had by electrical stimulation with surging current.

Digital examination should be carried out from the seventh day onwards, and the suture line palpated. Any loca abscess formation or breakdown of the suture line is best treated by irrigations with warm antiseptic lotion through a proctoscope. Such dehiscence of the suture line will heal by second intention, and if extensive will pre dispose to stricture formation. If there is any tendency to a stricture, daily digital dilatation is indicated. If it become established, posterior proctotomy followed by dilation with Hegar s dilators will control most strictures. Dilatatior can be done by the patients themselves, and may in fact, have to be carried out for many months, and the patient require long surveillance.

Recurrence of the prolapse is not unknown, and function with regard to rectal sensation is sometimes impaired For these reasons certain modifications of the standard operation have been suggested.

[*The illustrations for this Chapter on Rectal Prolapse were drawn by Mr F Price*]

Bibliography

Cohn, I. (1942). *Amer J Surg* 57 444
Graham, R. (1942) *Ann Surg.*, **115**, 1007
Miles, W E. (1933) *Proc. R. Soc. Med.*, **26**, 1445.
Muir E. G (1954). *Proc R. Soc. Med* **48**, 33

RECTOSIGMOIDECTOMY FOR HIRSCHSPRUNG'S DISEASE

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PRE-OPERATIVE

Indications

The essential indication for this operation in a case of megacolon is that the barium enema examination should show a relatively contracted segment of rectum below the distended sigmoid. Because of the shallowness of the pelvis in the child the removal of this aganglionic portion of bowel and the anastomosis of the dilated colon to the anal canal is sometimes possible by a purely abdominal operation similar to the anterior resection for rectal cancer (*see* Part IV, page 83). More usually, however, its excision requires the "pull through" abdomino-anal technique worked out by Swenson of Boston.

Special pre-operative preparation

In the average case the bowel can be adequately emptied by giving liquid paraffin 2 ounces daily and assiduous administration of colonic washouts or enemas with a soapy solution twice daily over a period of 10–14 days. Massage of the colon through the abdominal wall during the lavage may help to break up the faecal masses. In addition colonic antisepsis is secured by the taking of sulphathalidine 10 g. daily by mouth in divided doses for 5–7 days, and oral streptomycin 1 g. twice daily for the last 2 or 3 days of the course.

Usually the above regime will secure satisfactory deflation, cleansing and sterilization of the gut so that a one-stage operation may be employed. Only rarely will these measures fail and then a temporary proximal colostomy will be required. Colostomy is also indicated as a preliminary step in two other types of case: (1) in the very young child below 10–12 months of age, in whom these pelvic operations are technically too difficult and (2) in the older child who is extremely undernourished or in whom a gross faecal impaction is present, and whose general health will be enormously improved by a period of colostomy drainage. Originally the favoured site for the colostomy was the right end of the transverse colon but more recently it has been found that better drainage is secured if the colostomy is placed low down in the distended sigmoid loop. At the subsequent resection operation the colostomy is excised together with the aganglionic segment of bowel being removed.

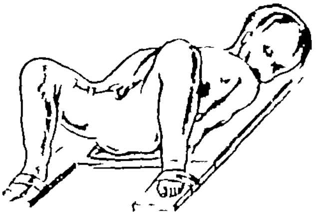
Anaesthesia

This is by general anaesthesia supplemented by relaxant drugs as required. The child has an intravenous drip running throughout the operation. An indwelling urethral catheter is inserted.

Position of patient

A modified lithotomy-Trendelenburg position is essential so that simultaneous access may be gained to both abdomen and perineum.

THE OPERATION

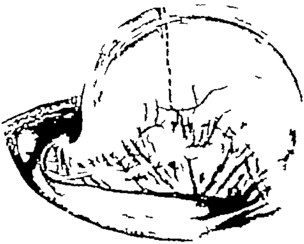


The incision

1 With the patient in the modified lithotomy-Trendelenburg position a long left paramedian incision extending from the pubis to well above the umbilicus gives adequate access.

Examination of the colon

2 The sharp transition from the dilated to the contracted bowel produces a very characteristic "cone effect" which is usually situated at about the rectosigmoid junction rarely more proximally even in the upper descending colon. It is essential that the upper limit of the resection should be at least 6 inches proximal to the cone, to ensure removal of all the aganglionic segment, and a couple of black silk sutches are inserted in the bowel wall at this level as markers for future guidance



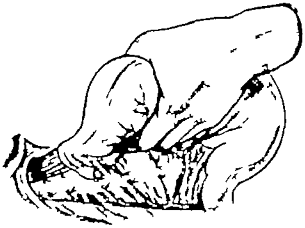
Incision of pelvic peritoneum and exposure of ureters and superior rectal and sigmoidal vessels

3 The sigmoid loop is held up the pelvic peritoneum is incised close to the rectum and both ureters are exposed and displaced laterally out of harm's way

The peritoneal incision on the right side of the rectum is prolonged upwards over the superior rectal vessels and across the sigmoid branches of the inferior mesenteric artery Sufficient of the sigmoid vessels are then ligated and divided to allow resection of the requisite amount of bowel. This may leave the left colic artery intact, but in really high resections it will have to be sacrificed. This will mean that the left colon will then be nourished solely by the middle colic and marginal vessels. The inferior mesenteric or superior rectal trunk itself need not be tied.

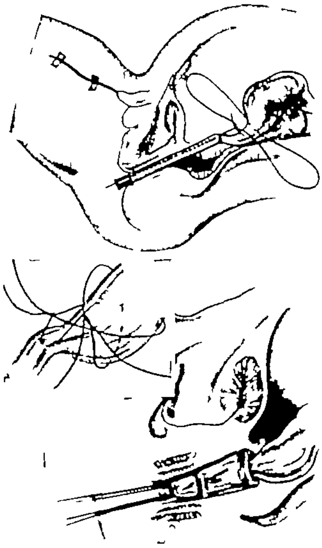
Mobilization of rectum

4 The rectum is now mobilized by "coring" it out of its bed of connective tissue in the pelvis, the plane of dissection keeping as close as possible to the rectal wall. Posteriorly this means going between the rectum and the main superior rectal vessels and dividing and ligating the terminal branches of these vessels as they run forwards into the bowel. This is a much more difficult and haemorrhagic plane than the one behind the main vessels employed in excisions for rectal cancer but it probably offers greater protection to the innervation of the bladder and sexual organs. The mobilization proceeds down to the ano-rectal ring and levator muscles.



Prolapsing of bowel through anus

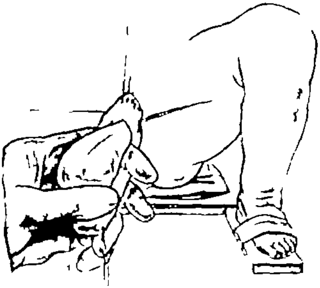
5 Several techniques are available at this stage but a good one is that of Denis Browne of intussuscepting the sigmoid through the anus. To do this a sigmoidoscope is passed well up into the sigmoid loop by a perineal assistant. Special 14-inch long needles, 2 in number are then inserted by the abdominal operator through the end of the sigmoidoscope to the exterior carrying with them 2 threads which are looped on the bowel. The result is that when the sigmoidoscope and needles are withdrawn 2 traction threads are available to prolapse the sigmoid through the anus. When this has been done the pelvic peritoneum is sutured and extraperitoneal suprapubic drains laid down to the pelvic space. The abdomen is then closed.



Amputation and anastomosis of prolapsed bowel

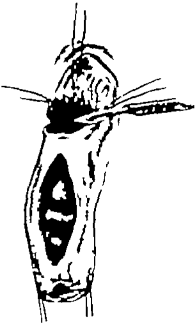
Longitudinal incision

6 A longitudinal incision is made with diathermy on the front of the prolapse through its outer layer alone. The inner tube of bowel is then hooked down with the finger till the black silk marking stitches come into view and four mattress sutures of catgut are inserted between the inner and outer layers in the north, south, east and west positions ½-inch beyond the muco-cutaneous junction.



Transverse incision

7 The tails of these sutures are used as stays whilst a transverse incision is made just distal to them, again through both layers. As this cut is extended progressively round the circumference of the bowel, the inner and outer layers on the upper side are co-apted by a close series of interrupted chromic catgut sutures.



Replacement of anastomosis inside pelvis

8 The stay sutures are now cut short and the anastomosis allowed to recede through the anus into the pelvis. The final state of affairs is a very low colo-rectal—almost colo-anal—suture line.

SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

Intravenous or subcutaneous fluids are required for the first 2 or 3 days and gastric suction is maintained till the fluid aspirated becomes clear Penicillin or other antibiotic is administered systemically

If a preliminary transverse colostomy was established it is closed 14 days or so after the rectosigmoidectomy, provided that the rectal anastomosis is healing satisfactorily

Leakage at the anastomosis may occur but is not usually serious if the site has been drained. A transverse colostomy may be necessary to induce the resulting suprapubic fistula to close.

Peritonitis due to leakage is rare.

Stricture at the anastomosis is not uncommon and may require regular dilation.

Transient retention of urine is a fairly frequent complication but permanent bladder dysfunction should be rare with the above technique of operation.

The functional results are difficult to assess in these young children but many of the older ones appear to have normal continence.

[*The illustrations for this Chapter on Rectosigmoidectomy for Hirschsprung's Disease were drawn by Miss Mary D Brown*]

Bibliography

Stephens, F D (1950) *Ann. roy Coll Surg Engl.,* 7 257
Swenson, O (1950) *Surgery* 28 371

EXCISION OF PILONIDAL SINUS

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PRE-OPERATIVE

Indications

A pilonidal sinus does not usually cause symptoms until it becomes infected and so gives rise to recurrent abscesses or a persistent discharge Once these symptoms occur it should be excised, otherwise it will continue to give trouble.

Dimples at the level of the sacro-coccygeal joint are not infrequently seen in children and these should be left alone as should the symptom-free sinuses that occur in adults.

Special contra-indications

Excision is not undertaken if the main sinus or any of the satellite sinuses are acutely inflamed. Penicillin and streptomycin should be given, and if there is pus present simple incision and drainage is carried out. It is not excised until the acute infection has subsided.

Pre-operative preparation

If there is any discharge from a sinus a pus swab is taken so that the organisms can be cultured and their sensitivity to antibiotics determined. The appropriate antibiotic is started 24 hours before operation.

The bowels must be prepared as for an operation on the rectum. A satisfactory method is to give a drachm of Cascara Sagrada Elixir (*B.P*) on the evening but one before the operation and then on the following evening a rectal washout is done using tapwater

On the day of operation, the buttocks and perineum are shaved, particular care being taken to remove all the hair in the natal cleft, and finally a hot bath is given and the area is thoroughly washed.

Anaesthesia

A general anaesthetic is necessary and an endotracheal tube must be passed so that the operation can be done with the patient on his face.

Purpose of operation

The object is to remove a block of tissue containing the primary sinus or sinuses and any ramifications that may be present. An attempt may be made to outline the sinuses by an injection of gentian violet just before the incision is made but often it does not penetrate far and is not usually very helpful.

Position

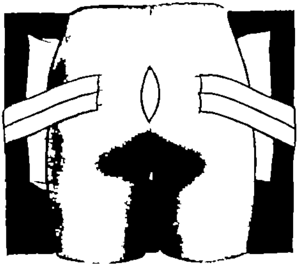
The patient should be flat on the table with a pillow under the pelvis and the legs slightly apart. Strips of Elastoplast are attached to each buttock and then to the sides of the table so that the buttocks are pulled apart. If the skin is cleaned with ether the Elastoplast is less likely to come off.

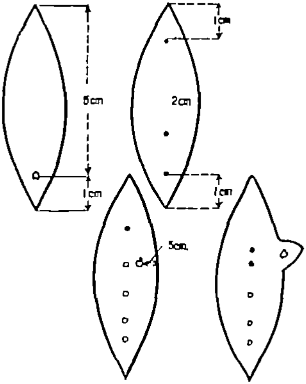
When the sterile towels are applied, great care should be taken to see that the anus is well covered and outside the operative field.

THE OPERATION

Incision

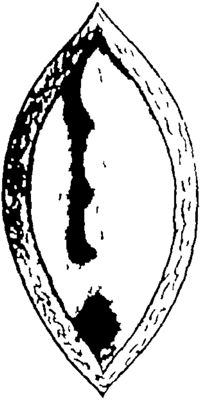
1 Where there is a solitary primary opening, an elliptical incision is made which extends 1 cm. below 5 cm. above and 1 cm. on each side of the midline. If there is more than one midline sinus, the incision extends 1 cm. below the lowest sinus and 1 cm. above the highest and again 1 cm. on each side of the midline.





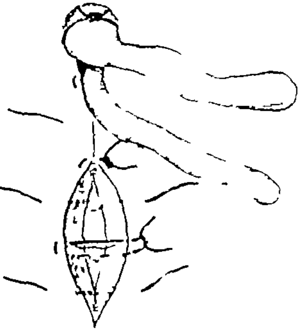
Lateral sinuses

2 Where there are lateral sinuses the incision should pass 0·5 cm. on their lateral side. If this would result in too much tissue being removed so that the closure would be difficult, then the lateral sinus may be removed by means of a lateral wedge at right angles to the main incision.



Depth of incision

3 The incision should be carried vertically down to the periosteum over the sacrum and the fascia over the glutei muscles. If the defect is wide then the skin edges must be undercut. Before closure of the wound is started, complete haemostasis must be attained preferably by means of pressure and hot packs. Diathermy may have to be used on some of the large vessels, but catgut must not be buried in the wound.



Suturing

4 The success of the operation largely depends on good apposition of the skin edges and the obliteration of the dead space without the use of buried sutures.

The strapping is removed so that the buttocks can come together

For the first layer 30 s.w.g. stainless steel wire is used on a large curved cutting needle. Each suture passes through the skin, about 1½ inches from the wound edge the subcutaneous tissue and picks up the periosteum over the sacrum. A series of these sutures are inserted and the ends are held with artery forceps. For the second layer 35 s w g wire is used and this layer consists of vertical mattress sutures. A smaller curved cutting needle is used and again the periosteum over the sacrum is picked up. When all these sutures have been placed and held with artery forceps they are tied and the ends are left long.

COMBINED EXCISION OF THE RECTUM

O V LLOYD-DAVIES, M.S., F.R.C.S.

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PRE-OPERATIVE

There are three established methods of combined excision the abdomino-perineal (Miles) perineo-abdominal (Grey Turner and Gabriel) and the synchronous.

In the first two methods the patient is turned between the abdominal and perineal stages. In the synchronous method the abdomen and the perineum are exposed throughout the operation by using special leg supports and placing the patient in the lithotomy-Trendelenburg position.

Indications

Operation is indicated where there are (1) primary malignant tumours of the rectum and anal canal (2) secondary extension into the rectum from malignant disease in adjacent organs, for example, the vagina or uterus (3) extensive involvement of the rectum by benign tumours, adenomas and papillomas in which diathermy fulgaration is not feasible and (4) severe rectal involvement in ulcerative colitis and other granulomatous conditions.

Contra-indications

Operation is contra-indicated in patients totally unfit for operation on general grounds cases with gross hepatic metastases and patients with general peritoneal metastases

Pre-operative preparation

The patient should be admitted at least 5 days before operation for a thorough physical examination. The chest should be x-rayed and any catarrhal condition treated.

Laboratory tests including a blood count, blood grouping, blood-urea estimation and urine examination should be done and any anaemia treated by blood transfusion. It is advisable that the haemoglobin should be at least 80 per cent before operation. In severe cases of prostatic obstruction it is often wiser to relieve this before the excision operation

Bowel preparation

Only mild aperients such as magnesium hydroxide and medicinal paraffin and daily enemas or colonic washouts are given Aperients should be stopped 36 hours before operation and a final washout given on the evening prior to the operation. Phthalylsulphathiazole 10 g daily in divided doses is given for 5 days before operation and oral streptomycin 1 g twice daily for the last 2 pre-operative days.

Anaesthesia

Omnopon gr $\frac{1}{3}$ and scopolamine gr $\frac{1}{150}$ are given one hour before operation and the patient induced with thiopentone followed by gas and oxygen, with muscular relaxants and further thiopentone when necessary

As soon as the patient is anaesthetized a catheter is passed and complete emptying ensured by supra-pubic pressure which should be sustained until the catheter is spigotted, thus preventing air entering the bladder and reducing the available working space in the pelvis. In males the catheter is tied in or a self retaining catheter used and the penis and scrotum strapped to the right thigh

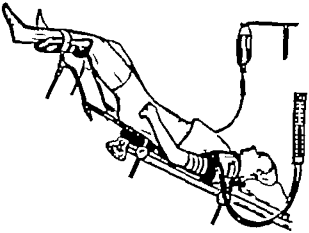
An intravenous drip is essential and is set up before the start of the operation

THE OPERATIONS

SYNCHRONOUS METHOD OF EXCISION OF THE RECTUM

Position

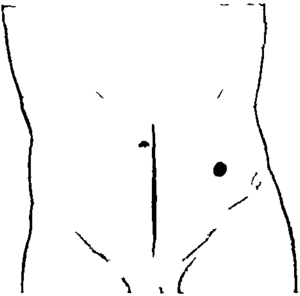
1 Note the special leg supports, the lithotomy-Trendelenburg position and the sacrum raised on a sand bag. With the patient in this position two surgeons may work together one in the abdomen and the other in the perineum with no hindrance to either. This position may be used by a surgeon working alone and an abdomino-perineal or perineo-abdominal operation performed. The distinguishing features between these two methods are the timing of the various procedures and the amount of dissection carried out from either the abdominal or perineal aspect.

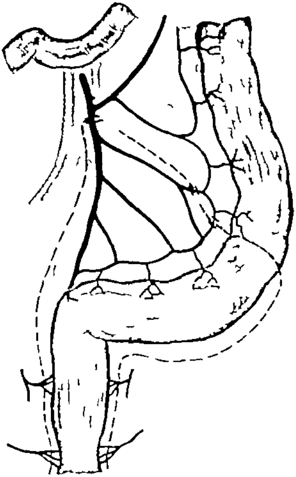


ABDOMINAL EXPLORATION AND DISSECTION

Incision

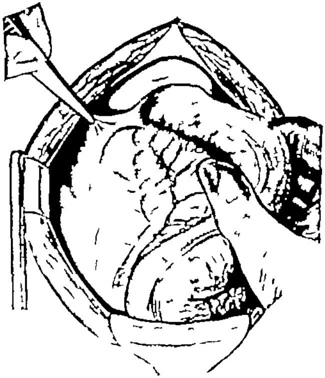
2 A long lower left or right paramedian muscle sliding incision is made and extends from about 1½ inches above the umbilicus to the pubes. The abdomen is then systematically examined, commencing with the liver and concluding in the pelvis.
The site of the colostomy is here shown at a point about two inches along the line from the anterior superior iliac spine to the umbilicus.





Extent of bowel removal

3 The plan of the vascular and lymphatic field which is to be removed shows an average arrangement of the vessels to be ligated inferior mesenteric, middle and inferior haemorrhoidal.

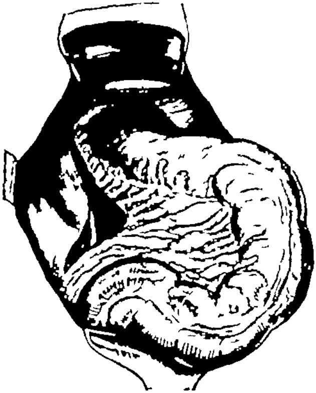


Raising of colon

4 The small intestine is packed away from the pelvis and the iliac portion of the colon raised by incising the congenital peritoneal folds attached to the lateral aspect of its mesentery The vascular supply to the colon may now be approached from either side of the mesentery and trans-illuminated when necessary

Mesenteric Incision

5 An incision is now made on the lateral side of the base of the sigmoid mesentery as it crosses the pelvic brim and the left ureter exposed The ureter is then gently swept away from the base of the meso-sigmoid to prevent its inclusion in the vascular pedicle



Ligation of pedicle

6 An incision is made on the medial side of the base of the meso-sigmoid and the base of the mesentery elevated from the posterior abdominal wall.

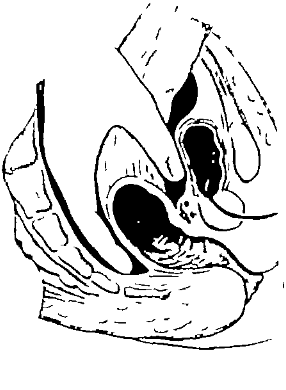
The vascular arrangement, which is variable, is inspected and the pedicle ligated as high as possible to ensure the widest possible removal of upward lymphatic field, at the same time ensuring an adequate blood supply to the colostomy The ligature should be of strong material, such as No 18 thread.

The descending branch of the left colic artery here supplies the colostomy but should this vessel be small in calibre it is wiser to leave the first sigmoid artery Alternatively when there is marked upward lymphatic extension it may be desirable to take the whole inferior mesenteric trunk at its origin, but before embarking on this it is most important to determine that the blood supply to the left colon from the middle colic vessels is adequate.

7

Production of line of cleavage

The recto-sigmoid mesentery is lifted forwards from the promontory of the sacrum and a pair of blunt-ended scissors inserted in the mid-line downwards and backwards immediately in front of the first piece of the sacrum and behind the meso-rectum a presacral line of cleavage is thus produced.



8

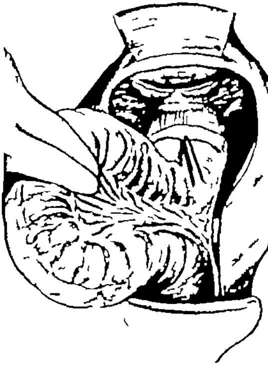
Further mobilization

The fingers and finally the hand are introduced into this presacral space and the meso-rectum deliberately pushed forwards from the front of the sacrum and the sides of the pelvis as far downwards as the coccyx. Any tough strands of pelvic fascia are divided with scissors. At this stage the abdominal and perineal dissections meet behind the meso-rectum, the rectum being completely free posteriorly (*see* Illustration 21)

Peritoneal incisions

9 The peritoneum and sub-peritoneal tissues are incised on either side of the bowel as far down as the peritoneal reflection and the two incisions joined anteriorly just in front of the lowest part of the peritoneal pouch

The course of the ureters should be carefully noted during this stage and in cases of bulky tumours in the mid-pelvis both ureters should be exposed throughout their course to the bladder



Incision in fascia of Denonvillier

10 The apex of the incised peritoneum is drawn upwards and the base of the bladder and both vesicles (or vaginal wall) exposed by blunt-nosed scissor dissection.

The fascia of Denonvillier now seen on the anterior rectal wall is incised transversely and a distinct line of cleavage extending downwards as far as the apex of the prostate will be found with the fingers. Whilst in this space the fingers are swept laterally to define the anterior borders of the lateral ligaments.

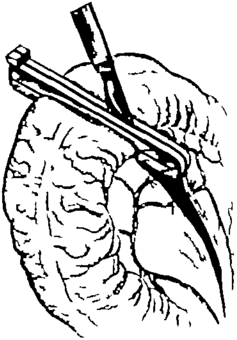
Division of lateral ligaments

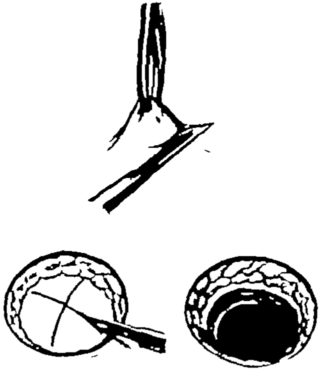
11 Each lateral ligament is in turn made taut by displacing the rectum to the opposite side with the left hand and then divided with scissors well out on the pelvic wall and as far downwards as possible. Any remaining portions will be divided by the perineal operator (*see* Illustration 26). The middle haemorrhoidal arteries will require ligation.

The abdominal dissection is now complete, the remaining direction being left to the perineal operator.

Division of colon

12 The colon is prepared for division by dividing the arcade between the left colic artery and first sigmoid artery at a point which will allow two inches of viable colon to project through the abdominal wall at the site of the colostomy. The mesentery should be divided at right angles to the bowel. The bowel is divided between small clamps such as those of Zachary Cope.





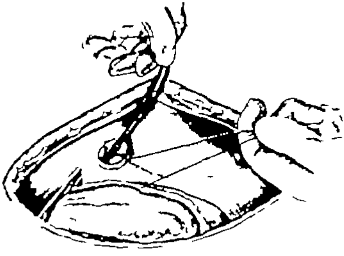
Colostomy Incision

13 A circle of skin not more than one inch in diameter is excised at a point two inches along the line from the anterior superior iliac spine to the umbilicus.

A stab incision is made through the abdominal wall the external oblique fibres being divided transversely to avoid constriction of the bowel

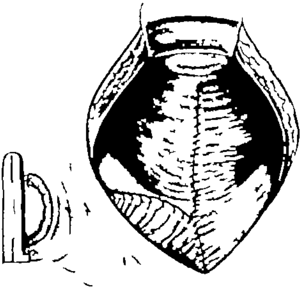
Passing of colon through incision

14 The left border of the laparotomy wound is now elevated by passing a long forceps through the colostomy incision and the para-colic gutter is exposed. A purse-string suture is inserted from the lateral edge of the colostomy site including some muscle fibres and continued under the peritoneum of the paracolic gutter to the mesenteric border of the colon when tied the space to the outer side of the colostomy is obliterated and this prevents small bowel obstruction through what would otherwise be a narrow foramen The proximal clamped colon is passed through the colostomy incision and the perineal dissection having been completed the excised colon and rectum are withdrawn through the perineum.



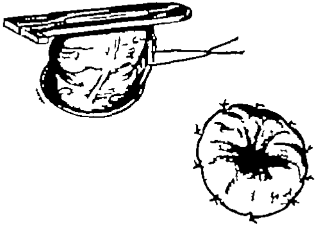
Closure of abdomen

15 Pelvic haemostasis is completed and the peritoneum from the lateral walls of the pelvis and iliac fossae gently mobilized with the fingers. The peritoneum is closed over the empty pelvis by an invaginating continuous Lembert suture to diminish the chance of adhesion formation.
The main pedicle ligature is covered during this process and the suture continued laterally between the free edge of the meso-colon and the peritoneum of the left iliac fossa to the point of exit of the colon. The abdomen is closed without drainage and the wound sealed with Whitehead's varnish and a waterproof top dressing



Formation of colostomy stoma

16 If the proximal colon is loaded, early and often violent bowel actions may occur and it is wiser to tie in a Paul's tube, the colostomy being trimmed when necessary at a later date. When the bowel is relatively empty the colon may be trimmed to leave one inch projecting above the skin surface The edges of all coats of the colon are carefully sutured to the surrounding skin with interrupted No 1 chromic catgut sutures $\frac{1}{4}$ inch apart. This produces a very satisfactory stoma with no tendency to skin stenosis.



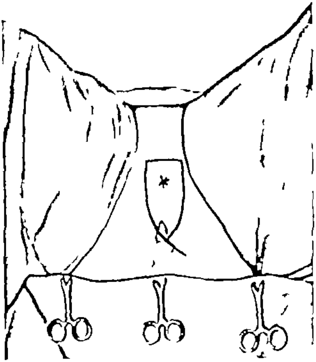
PERINEAL DISSECTION

Incision

17 The anus is closed with a subcutaneous suture of strong silk to prevent soiling No dissection is commenced until the abdominal surgeon has completed the exploration and decided that a combined excision is the correct procedure

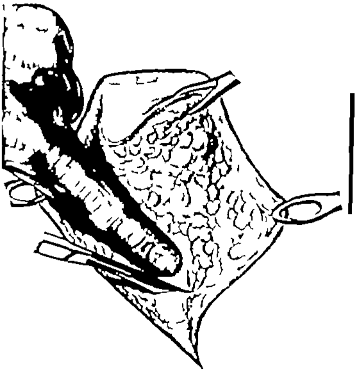
A transverse incision 2 inches in length is made in front of the anus midway between it and the bulb of the urethra

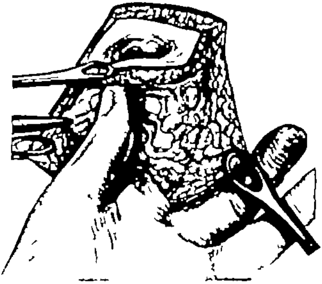
Lateral incisions are now made from its extremity and extend backwards to meet over the sacro-coccygeal articulation These incisions are deepened until the lobulated fat of the ischio-rectal fossa is seen and the coccyx exposed.



Removal of part of coccyx

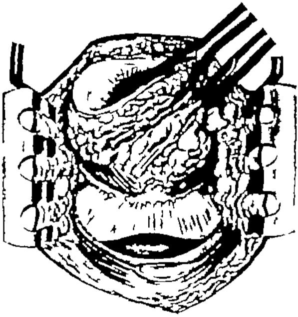
18 The coccyx is now flexed to open up a coccygeal joint and the point of a scalpel inserted. The distal portion of the coccyx is removed, care being taken to keep the knife close to the superior surface of the bone to avoid damaging the rectum. The middle sacral vessels may require ligation at this stage. Removal of a portion of the coccyx usually facilitates the dissection.





Isolation and division of ilio-coccygeus muscles

19 Small lateral incisions are made on either side of the coccyx through the fibrous attachment of the coccygeus muscle and a finger is inserted on each side in a forward and outward direction to separate the ilio-coccygeus muscle from the underlying rectal fascia of Waldeyer. The overlying ischio-rectal fossa fat and ilio-coccygeus muscles are now divided well out on the lateral walls of the pelvis. The inferior haemorrhoidal vessels require ligation.



Exposure of meso-rectum

20 A self retaining perineal retractor (such as St. Mark's Hospital pattern) is placed in position and the fascia of Waldeyer incised just in front of the divided coccyx. This incision is continued laterally at the level of the bony pelvic outlet exposing the meso-rectum.

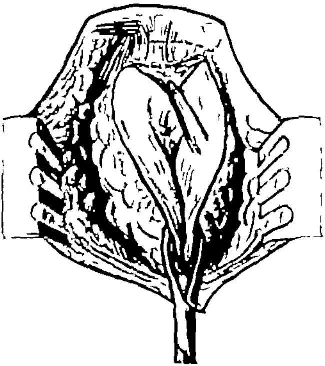
Separation of meso-rectum

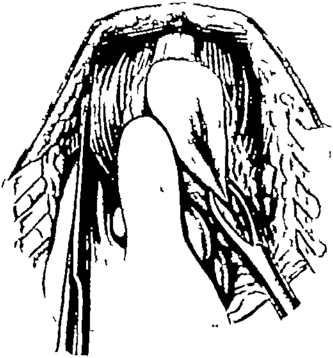
21 The fingers are inserted in front of the cut edge of the fascia and the meso-rectum can be safely separated from the front of the sacrum and lateral pelvic walls to the level of the sacral promontory

Perineal and abdominal operators meet in this plane at this period in the operation (Illustration 8) the rectum being completely freed posteriorly

Anterior dissection

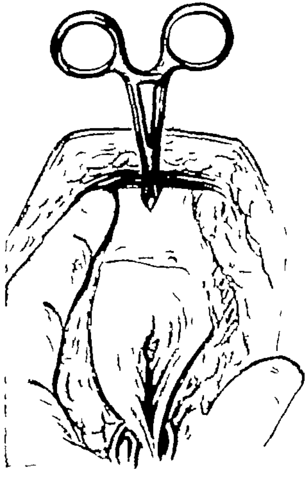
22 Traction is made on the isolated skin in front of the anus, and by transverse incisions on either side the wound is deepened to expose the superficial and then the deep transverse perineal muscles. The plane of the dissection must be behind these muscles to avoid injury to the urethra and when the deep transverse perineal muscles are completely exposed, by dividing the decussating fibres of the external sphincter muscle, the whitish longitudinal fibres of the anterior rectal wall will be seen.





Separation and division of pubo-coccygeus muscles

23 The broad strap-like pubo-coccygeus muscles now become evident on either side of the rectum and prostate or vagina. A finger is inserted between the superior borders of these muscles separating them from the meso-rectum whilst they are being divided almost completely from their origins on each side.



Separation and division of fibro-muscular bundle

24 The plane of the posterior aspect of the prostatic gland can now be easily palpated and the position of its apex assessed.

The thick inferior borders of the pubo-coccygei (pubo-rectalis) together with longitudinal muscle fibres passing from the anterior rectal wall to the apex of the prostate and membranous urethra (recto-urethralis muscle) still hold the ano-rectal junction forwards in the middle line

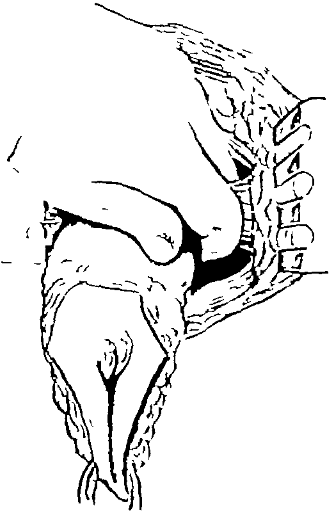
This barrier is separated into two bundles by blunt dissection with an artery forceps. The forceps are directed towards the located apex of the prostate and must lie parallel with the posterior aspect of the gland to avoid injury to the urethra. The separated fibro-muscular bundles are divided in turn and the capsule of the prostate exposed.

Occasionally a few readily-recognized longitudinal fibres obscure the capsule and require separate division to avoid injury to the rectum and expose the true plane of cleavage which will already have been found by the abdominal operator

Division of pelvic fascia

25 Vascular visceral pelvic fascia covering the meso-rectum and passing forwards to the lateral aspects of the prostate is divided frequently several vessels require ligation

Removal of bowel closure



26 The anterior and posterior aspects of the rectum are now completely isolated and the remaining lower postero-lateral portions of the lateral ligaments may require division if this has not been completed from the abdominal aspect.

The bowel is alternatively displaced to the opposite side and the stretched ligament divided close to the pelvic wall.

The bowel is passed down from the abdomen and removed through the perineum Haemostasis is secured and to avoid the risk of reactionary haemorrhage the blood pressure at this stage should be not much lower than the patient's normal.

The skin is sutured with vertical mattress sutures, a corrugated rubber drain being inserted through the centre of the wound. When the peritoneal pelvic floor is high and thin a rubber bag lightly packed with gauze should be inserted into the pelvic cavity to give temporary support for the first three post-operative days.

In the female the dissection is similar but when the growth is adjacent or in apposition to the vagina the whole of the posterior and lateral walls of the vagina should be removed with the rectum No attempt at reconstructing the vagina is necessary The whole perineal skin incision is sutured to reform the vaginal orifice through which the pelvic cavity is drained with corrugated rubber

ABDOMINO-PERINEAL EXCISION

In this operation the abdominal dissection is exactly as already described.

The distal divided bowel held in a Zachary Cope clamp is pushed down into the pelvis and the peritoneal pelvic floor reconstructed over it.

In order to obtain sufficient peritoneum to cover the bulky bowel it is necessary to mobilize the peritoneum more extensively particularly from the bladder

At the conclusion of the abdominal phase the patient is turned into the right lateral position for the perineal dissection.

After division of the fascia of Waldeyer the hand is passed between the meso-rectum and sacrum and the freed portion of the bowel delivered through the perineum.

By traction on the freed portion of the bowel the prostatic capsule will be seen and the anterior dissection completed from above downwards by scalpel dissection, dividing first the visceral pelvic fascia on either side of the prostate, the pubo-coccyges and recto-urethralis muscles and finally the decussating fibres of the external sphincter at the central point of the perineum.

PERINEO-ABDOMINAL EXCISION

This method is favoured by those experienced in perineal dissection of the rectum. The abdomen is first explored through a right paramedian incision and then temporarily closed. The patient is then turned into the left lateral position for the perineal dissection, which is similar to that already described, except that the whole of the lateral ligaments are divided and the peritoneal pouch is opened from below When the upper border of the prostate is reached, following division of the vascular visceral pelvic fascia on either side of the prostate, the vesicles should be identified. Occasionally these structures may be covered by the stout posterior layer of Denonvillier s fascia which in such cases requires incision to expose them The recto-vesical peritoneal pouch is now opened at this level by division towards the anterior rectal wall The incision of the peritoneum is carried upwards for several inches on either side of the meso-rectum into the pelvis.

The anal canal and anus are now enclosed in a rubber glove, swabbed with saline solution and pushed upwards into the abdominal cavity The anterior free edge of peritoneum is then partially sutured from below with a continuous suture and the needle and catgut are wrapped in a small gauze swab for protection of the needle and later identification from above The perineal wound is closed around a corrugated rubber drain

The patient is returned to the dorsal position, with the table placed in a moderate Trendelenburg tilt. The abdominal wound is now re-opened. The peritoneal incisions on either side of the meso-rectum are extended upwards and the growth delivered into the abdomen The inferior mesenteric pedicle is now ligated.

A muscle-splitting and cutting incision, 3–4 inches long, is made in the left iliac fossa. The lateral peritoneal space is closed through the iliac incision and the undivided bowel is delivered through this wound. The peritoneal pelvic floor is reconstructed over an empty pelvis utilizing the suture already used from the perineal wound and the abdomen closed. Finally the incision in the left iliac fossa is closed snugly around the issuing colon tight enough to allow one finger to pass easily along the colon into the abdominal cavity A few interrupted sutures carefully placed between the peritoneum or internal oblique muscle and the colon prevent retraction. Transverse incisions of the external oblique aponeurosis will prevent constriction at this level. Both wounds are now sealed and dressed and the bowel is divided between clamps and a rubber tube tied into the emerging bowel.

POST-OPERATIVE CARE AND COMPLICATIONS

These are of particular importance after operations which have included removal of the rectum because not only may the patient suffer from any of the complications of a major abdominal operation but, in addition, the colostomy urinary tract and perineal wound require special attention.

Whole-blood transfusion

The transfusion of whole blood given during the operation may be continued afterwards. It is usually necessary to follow this with an intravenous infusion of 1/5 normal saline solution and 4·3 per cent dextrose until normal peristalsis returns and flatus is passed per colostomy. This usually occurs within 2–3 days.

Gastric complications

Small quantities of water may be given by mouth after 24 hours, but if symptoms of nausea develop or any epigastric distension occur gastric aspiration should be instituted and any large quantities of fluid obtained should be replaced via the drip using normal saline solution.

Intestinal obstruction

Intestinal obstruction after this operation has been discussed by Goligher, Lloyd Davies and Robertson (1951). Careful attention to the technique of the operation will prevent the occurrence of this complication, especially when particular attention is paid to the closure of the lateral space beside the colostomy.

Physiotherapy

Breathing exercises and leg movements in bed should be encouraged from the first post-operative day and these where possible should be given under the guidance of a physiotherapist.

Pulmonary complications

The incidence of pulmonary embolism and other post-operative pulmonary complications will be reduced by adequate ventilation of the lungs, particularly the bases, and by active leg movements.

The perineal wound

The perineal wound is closed with drainage in most patients. The dead space between the skin and the pelvic peritoneum will be obliterated more rapidly if the patient is encouraged to sit up or if the head of the bed is raised as soon as the general condition of the patient permits—usually after a period of 24 hours. The drain is removed on the third post-operative day and the perineal skin sutures 6 days after the operation, the scar then being supported by adhesive strapping.

If it has been necessary to pack the wound, the gauze is gradually removed from the rubber bag during the first 3 days after which the bag itself is removed. The perineal cavity is irrigated each day with an antiseptic solution until it is nearly flat, when skin healing takes place by second intention.

Retention of urine

Urinary retention is best treated by prevention with an indwelling catheter of the Foley type and some form of closed drainage to prevent infection, although in the female intermittent catheterization may be used provided that no pool of residual urine is allowed to accumulate. The catheter will have been inserted in the operating room at the beginning of the operation and it is usually necessary to leave it in position for 4–5 days, after which an injection of 1 ml. of carbachol will help the patient to micturate. Of the methods of closed drainage the one devised by Cuthbert Dukes which uses the apparatus known as the St. Mark's Hospital retained catheter apparatus is satisfactory. In a number of cases repeated catheterization may be necessary for a period of from 2 to 3 weeks and even with the greatest of care urinary infection must be anticipated and the appropriate drugs should be given.

The colostomy

The action of the colostomy is usually spontaneous and it will be found that on the fourth or fifth day after the operation flatus will have been passed. Should delay occur a glycerin suppository may be inserted into the colon, but in the absence of distension it is usually wise to leave the bowel alone until it begins to function naturally. Only occasionally will an enema be required.

In the early post-operative days the colostomy is covered with a dressing of non-adhesive gauze and liquid paraffin or tulle gras under a large pad of absorbent gauze and wool. Later the patient is provided with a light colostomy belt.

For advice to the patient on the management of the colostomy the reader is referred to the St. Mark's Hospital booklet on this subject which is given to each patient after an operation of this type (Dukes, 1947)

[The illustrations for this Chapter on Combined Excision of the Rectum were drawn by Mr R. N Lane]

Bibliography

Dukes, C. E. (1947). *Lancet* **2**, 12.
Gabriel, W B (1948) *The Principles and Practice of Rectal Surgery* 4th Ed. London Lewis.
Goligher J C., Lloyd-Davies, O V., and Robertson, C. T (1951). *Brit J Surg.*, **38**, 467
Lloyd-Davies, O V (1938). *Lancet* **2**, 74
Miles, W E. (1914). *Brit J Surg.*, **2**, 292.

RESECTIONS WITH RESTORATION OF CONTINUITY FOR RECTAL CANCER

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PRE-OPERATIVE

Indications

Sphincter-saving resections are best reserved for carcinomas of the rectosigmoid or upper third of the rectum —that is for growths not less than 10 cm from the anal verge as measured by the sigmoidoscope, and either impalpable or only just within reach of the finger on digital examination A biopsy of the lesion should always be performed to exclude highly active anaplastic growths which, because of their notorious tendency to extensive and irregular spread are unsuitable for conservative resection For upper rectal carcinomas of average or lower grade of malignancy there is an excellent theoretical basis for resection operations as a radical procedure. Local recurrences have undoubtedly sometimes been encountered after their use in practice but 5-year follow-up studies of large series of cases recently reported from the Mayo Clinic by Judd and Bellegie (1952) and by Waugh, Miller and Kurzweg (1954) show that despite these unfavourable developments sphincter-saving resections apparently offer as good a chance of cure as does abdomino-perineal excision for growths of the upper third of the rectum or of the rectosigmoid. Most surgeons will wish to see these American statistics confirmed before reaching a final decision on the value of resection in the radical treatment of rectal cancer but whatever may prove to be the ultimate verdict on them as radical operations, their place is already assured for two categories of cases

(1) For the patient with a locally resectable rectosigmoid or upper rectal growth which is incurable because of the presence of hepatic metastases A sphincter-saving resection in this type of case is a much more attractive palliative method of removing the primary growth than is an abdomino-perineal with permanent colostomy

(2) For the patient with a large villous papilloma of the upper or middle third of the rectum which cannot be delivered through the anus. Here a sphincter-saving segmental resection is a more satisfactory treatment than attempted fulguration or complete rectal excision with a colostomy

Choice of technique

Several different forms of sphincter-saving resection are available, for the operation may be performed by abdominal, abdomino-anal abdomino-sacral, or sacral routes. The sacral operation does not allow of a really high ligation of the inferior mesenteric vessels and both it and the abdomino-sacral method are liable to be complicated by the development of a persistent faecal fistula through the sacral wound. The most popular and immediately successful method is undoubtedly the purely abdominal resection—the low anterior resection of American surgeons. This operation is nearly always technically feasible for growths above the peritoneal reflection. Only very rarely as for example when operating on a rather obese subject with a narrow pelvis or attempting a palliative resection for a rather lower growth than would normally be accepted for a radical sphincter-saving excision is it necessary to resort to the fourth method—namely abdomino-anal resection There are two main ways of performing this latter operation—the "pull through method of Babcock (1932) and Bacon (1945) and the evagination technique of Maunsell (1892) and Weir (1901) The former method, which entails pulling the colon stump through the anal canal denuded of its lining mucosa and skin is usually followed by imperfect functional results due to impairment of normal rectal sensation. The latter method carefully preserves the sensitive ano-rectal mucosa, and secures union between the colon and ano-rectal stump by turning the latter inside out through the anus, drawing the colon down through it, and suturing together the cut edges of the two stumps from below as a

tailor stitches the sleeve into the body of a jacket. Subsequently the anastomosis is returned through the anus to the pelvis. This method usually gives normal continence.

In this Chapter only two operations will be described—anterior resection and abdomino-anal resection of evagination type

Special pre-operative preparation

Preliminary or simultaneous proximal colostomy

If the patient is acutely obstructed or has a serious degree of subacute or chronic obstruction a proximal colostomy alone should be performed in the first instance. This may be sited in the right end of the transverse colon leaving the left half of the abdomen undisturbed for the subsequent resection two or three weeks later in which case the colostomy may be closed either at the conclusion of the second stage or as a separate third stage when the anastomosis has soundly healed Alternatively the colostomy may be placed in the sigmoid colon a few inches proximal to the growth, as recently recommended by Waugh of the Mayo Clinic, and subsequently resected along with the growth at the main operation During the interval between the establishment of the colostomy and the resection the colon is prepared by daily washes-through from the colostomy to the anus or *vice versa* and by insertion of suppositories containing sulphathalidine into the colostomy In the ordinary unobstructed case, however a preliminary colostomy is not necessary but if the bowel is found at operation to be more heavily loaded than was anticipated, or if the anastomosis was effected only with difficulty it may be advisable to establish a temporary defunctioning transverse colostomy at the end of the resection.

For the average patient the local and general preparation differs in no essential respect from that employed for abdomino-perineal excision On arrival in the anaesthetic room the patient has an indwelling catheter inserted and the bladder emptied by compression, and an intravenous infusion set up in the right arm for administration of N/5 sodium chloride solution or blood as required during the operation.

Anaesthesia

General anaesthesia supplemented by relaxant drugs, or a spinal anaesthetic are satisfactory for these operations.

Position of patient

Anterior resection can be performed in an ordinary Trendelenburg position as employed for the abdominal part of the standard abdomino-perineal excision, but there are advantages in using the lithotomy-Trendelenburg position as for the synchronous combined excision. With the patient so positioned it is possible for an assistant to wash out the rectum from below with a 1/500 solution of perchloride of mercury through a proctoscope just before the bowel is divided and the anastomosis performed. This certainly diminishes faecal contamination in the pelvis during the operation, and may in addition help to minimize the risks of loose carcinoma cells becoming implanted in the suture line and giving rise subsequently to local recurrences. Also if it should be found at laparotomy that the growth is not suitable for anterior resection but is capable of being removed by an abdomino-anal technique the lithotomy-Trendelenburg position, which allows of simultaneous access to the abdomen and the perineum, is a very great convenience.

THE OPERATIONS

ANTERIOR RESECTION

The incision and exploration of abdomen

1 The abdomen is opened by a long left paramedian rectus-displacing incision extending from the pubis below to a point at least 2½–3 inches above the umbilicus, and farther if required. A general exploration is then carried out to determine the operability of the growth and to decide whether it is in fact suitable for anterior or abdomino-anal resection or whether it would be better treated by abdomino-perineal excision

Mobilization of sigmoid colon and exposure of inferior mesenteric vessels

2 If the primary growth should be so fixed that its operability seems doubtful obviously the operation must commence with a trial dissection of the rectum itself on its adherent aspects before any irrevocable step such as division of the main blood supply is taken. But, in the average case with a non-fixed growth, it is best to start with ligation of the inferior mesenteric vessels. For this manoeuvre it is a convenience to have the patient horizontal and tilted 25 degrees to the right and to stand on his right side as in Illustrations 1–5 The steps of the dissection leading up to exposure of the inferior mesenteric vessels are absolutely identical with those of the Miles operation, and the division of the adhesions on the outer side of the iliac colon, the incision of the peritoneum on either side of the base of the mesosigmoid and upper mesorectum, and the demonstration and lateral displacement of the left ureter being all carried out exactly as described for this latter operation

Exposure of inferior mesenteric vessels

3 The peritoneal incision on the right side of the mesocolon is now prolonged upwards over the abdominal aorta as far as the third part of the duodenum. The edges of this cut are separated and the duodenum is retracted headwards to expose the uppermost $2\frac{1}{2}$ inches of the inferior mesenteric vessels.

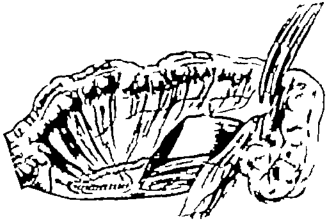
Ligation of inferior mesenteric vessels and preparation of colon stump

4 The inferior mesenteric artery is ligated and divided at its origin from the aorta, and the vein is tied separately at about the same level. Whilst the sigmoid loop is held up to the light to demonstrate its vessels an oblique incision is made with scissors in the mesosigmoid from the point of ligation of the main vessels to the marginal vessel just above the termination of the first sigmoid artery the left colic vessels being divided in the process. This leaves a colon stump nourished solely by the middle colic artery through the marginal vessel. If this supply seems adequate, as judged by the colour of the bowel and the pulsation of the vessels in its wall, the marginal artery is severed and the colon divided between Parker-Kerr clamps applied obliquely from the anti-mesenteric to the mesenteric border. In cases of doubt, confirmation of the sufficiency of the blood supply can be obtained by cutting one of the small mural arteries and noting whether this gives rise to arterial bleeding or not. If the slightest dubiety remains, the descending colon and splenic flexure should be mobilized by division of the peritoneum on their outer side so that the left colon may be drawn down and a point chosen on the descending or distal transverse colon for safe division of the bowel.

5

Commencement of posterior peritoneal suture

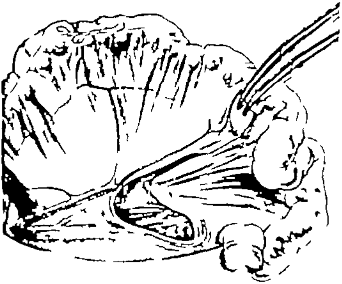
Before leaving this part of the operative field it is often convenient to start the suture between the right edge of the posterior parietal peritoneum and the peritoneal leaf to the colon stump to cover over the abdominal aorta as far as its bifurcation



6

Alternative plan of ligation in palliative resection

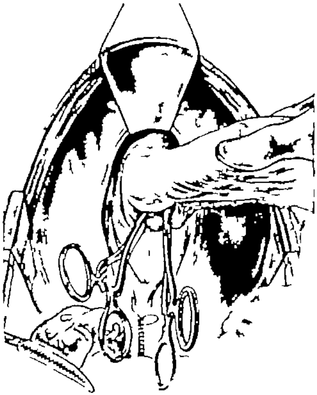
If the operation is being undertaken as a palliative procedure in a patient with hepatic metastases, obviously this high ligation of the inferior mesenteric vessels is unnecessary It suffices to place the ligature just below the level of the bifurcation of the abdominal aorta, which preserves a direct blood supply to the end of the colon stump through the intact first sigmoid branch.



Mobilization of rectum and prepara tion of rectal stump

7 For the remainder of the operation the patient is placed in a fairly steep Trendelenburg tilt. The freeing of the rectum from the sacrum posteriorly and from the bladder seminal vesicles and prostate anteriorly and the division of the lateral ligament on either side are carried out as in an abdomino-perineal excision, the end result being that the rectum is completely mobilized as far as the ano-rectal junction.

The next step is to separate the mesorectum from the back of the rectum at the level selected for division of the bowel below the growth, which should be not less than 2 inches from the inferior edge of the lesion This is done by scissor dissection aided by gauze-pushers. The mesorectum is now clamped with two large artery forceps or crushing intestinal clamps and divided between them. These ends are then tied off leaving the rectum bared all round over a segment about 1½ inches long at which the division of the bowel and anastomosis will take place.



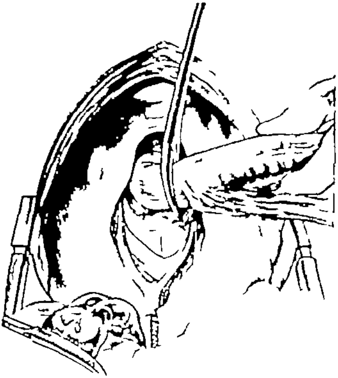
Alternative preparation of rectal stump in cases of rectosigmoid growths

8 If the growth should be at the rectosigmoid junction or in the extreme upper end of the rectum it is not necessary to mobilize the infra-peritoneal part of the rectum in this thorough fashion. Instead the cuts in the base of the mesosigmoid and upper mesorectum are carried forwards to the bowel 2 inches below the growth. The main superior haemorrhoidal vessels are divided between clamps. The lateral ligaments are not divided at all, though the rectum may be freed to some extent posteriorly by manual separation from the sacral concavity

Irrigation of the rectal stump

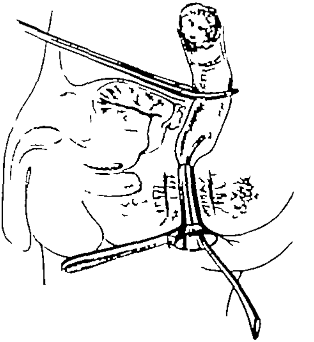
Clamping of rectum

9 Before dividing the rectum and proceeding to the anastomosis of the colon and rectal stump it is a good plan if the patient is in the lithotomy-Trendelenburg position to cleanse the bowel by an irrigation through a proctoscope. *This is useful in reducing the* amount of faecal contamination when the rectum is eventually divided and however quick the surgeon may be with his sucker there is liable to be some leakage of faeces at this stage. It also has the advantage that it washes away loose malignant cells with the faeces and this diminishes the risk of them becoming implanted in the suture line when the anastomosis is done. A solution of perchloride of mercury 1 500 is employed for this rectal irrigation in the hope that it may also act as a protoplasmic poison to any detached cancer cells and enhance its value in preventing implantation secondaries. Before the irrigation is commenced a curved Parker-Kerr clamp is applied across the rectum exactly in the sagittal or antero-posterior plane at least 1 inches below the distal edge of the growth and with its handles just above the pubes, to prevent further faeces descending into the lower segment of bowel.



Irrigation

10 An assistant now passes a proctoscope per anum and through a rubber catheter irrigates the rectum with 1½–2 pints of the solution. Finally the rectum is swabbed out with gauze to remove any remaining irrigating fluid and leave it dry ready for division and anastomosis by the abdominal operator



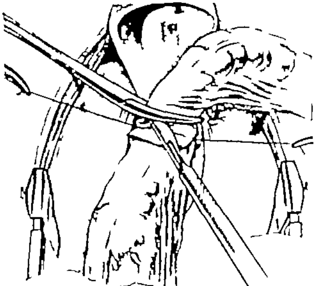
The anastomosis

Insertion of posterior Lembert sutures

11 The sigmoid and rectum above the Parker-Kerr clamp are now drawn vertically upwards to lift the lower rectum as far as possible out of the pelvis. The clamp controlling the end of the colon stump is placed on the left edge of the abdominal wound. A series of mattress Lembert sutures of fine serum proof silk is now inserted between the colon and the rectum ¼ inch below the occluding Parker-Kerr

Apposition of colon and rectal stump and tying of posterior Lembert sutures

12 When all the Lembert sutures have been placed the colon is slid down on them to come into apposition with the rectum, and the sutures are tied. The tails of the first and last stitch respectively are retained for traction, all the others being cut off. The crushing clamps are now excised with a scalpel and in the case of the rectum this means also removal of the entire operative specimen The cut edges and terminal part of the interior of the colon stump are swabbed with 1 : 500 perchloride of mercury

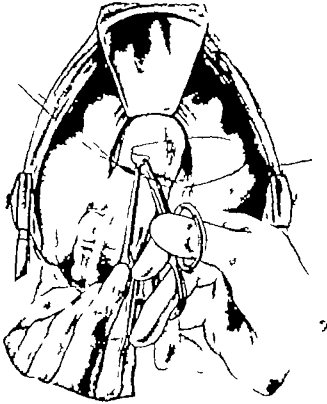


Insertion of posterior half of through-and-through continuous catgut stitch

13 A continuous No 1/0 or 2/0 chromic catgut suture on a fine curved atraumatic needle is used to unite the cut edges of colon and rectum This is started at the anterior or antimesenteric poles, being inserted from the outer aspect of the rectum to the peritoneal aspect of the colon through 4 thicknesses of bowel wall When tied the knot therefore lies outside the lumen. The needle is reintroduced through the rectal wall into the lumen for the posterior half of the suture which continues as an ordinary over-and-over stitch producing good inversion into the lumen of the bowel At the mesenteric poles of the lumen however it changes to a Connell or "loop on the mucosa" stitch.

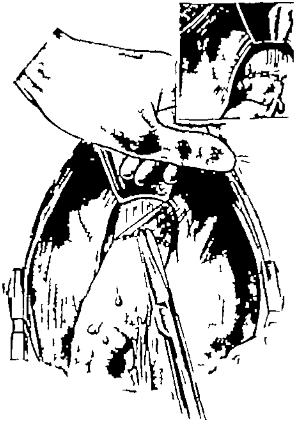
Insertion of anterior half of through-and-through stitch

14 This proceeds forwards as a Connell stitch to reach the antimesenteric poles where it is tied to the tail of the initial knot. Whatever the defect of this suture in gastric work where its indifferent haemostatic qualities may be held to be a serious disadvantage, it is ideal for the anterior portions of colonic anastomosis where the control of bleeding is never a problem. It gives very good inversion of the edges into the lumen of the bowel and avoids all mucosal pouting



15 *Insertion of anterior Lembert stitches*

The anastomosis is completed with an anterior row of Lembert sutures of fine silk inserted in mattress fashion to secure a better grip of the longitudinally running muscle fibres in the rectal wall. The tails of these are left long and held by the assistant, for traction on them facilitates the insertion of the next stitch.



16 **Drainage of pelvic space**

The pelvic cavity is now drained by a strip of corrugated rubber inserted extraperitoneally from the lower end of the abdominal wound beneath the pelvic peritoneum at the side of the bladder to the region of the anastomosis. The choice of a suprapubic extraperitoneal drain instead of a paracoccygeal one has been decided by two considerations. A drainage wound in the coccygeal region is liable to reinfection from the faeces when the bowels start acting. Also there is a risk—perhaps largely theoretical—that, if the suture line should give way and some faecal leakage result, the faeces might find it easier to continue discharging by this route instead of per anum, and a persistent faecal fistula might result in the same way as after resection by the sacral and abdomino-sacral routes.

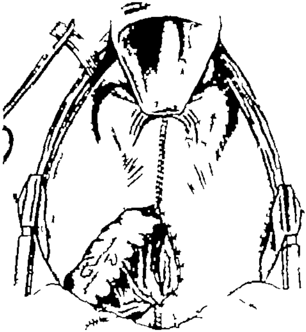
Suture of pelvic peritoneum

Commencement of closure

17 Using a small curved atraumatic needle and fine chronic catgut (No 1/0 or 2/0) the pelvic peritoneum is now sutured above the level of the anastomosis and above the hinder end of the drain

Completion of peritoneal closure

18 When this suture reaches the colon posteriorly it is terminated and the edges of the peritoneal leaves as they lie on either side of the colon are stitched to the bowel and on its right side to its mesocolon, care being taken to avoid vessels. Eventually the suture joins up with that introduced earlier in the operation to cover the abdominal aorta. The effect achieved is a complete re-peritonealization of the pelvis and a shutting off of the anastomosis in the pelvis so that if the bowel suture line were to leak subsequently the peritoneal cavity would be protected and the faeces would escape along the extra-peritoneal drain.



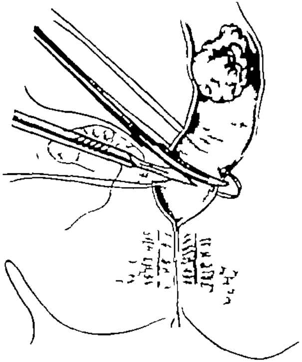
Closure of abdomen

The abdominal wound is closed in layers, the drain being brought out at its lower end or through a separate stab wound in the left iliac region

ABDOMINO-ANAL RESECTION

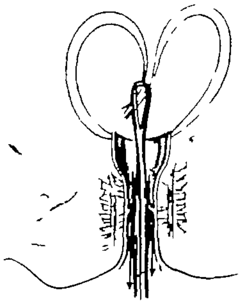
The initial steps follow the lines adopted in anterior resection, but a much longer colon stump is required, and, if a really high ligation of the inferior mesenteric vessels is practised, it is usually necessary to mobilize the splenic flexure in order to obtain enough bowel to extend outside the anus.

The rectum is freed down to the ano-rectal junction as in low anterior resection. A curved Parker-Kerr or right-angled clamp is then applied to the bowel but at a much lower level than in anterior resection usually about 1¼–1½ inches above the upper end of the anal canal The small ano-rectal stump can now be irrigated with 1 500 perchloride of mercury from below as shown above (Illustration 10)



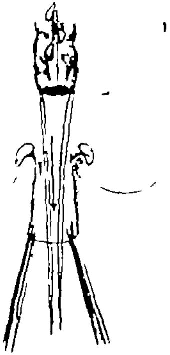
Insertion of stay sutures and division of rectum

19 After the irrigation has been completed two stay sutures of silk are inserted into the rectal stump in front and behind, and the bowel is divided between the sutures and the clamp removing the operative specimen and leaving a very small remnant of rectum low in the pelvis.



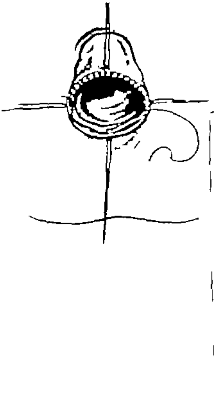
Eversion of ano-rectal stump

20 A scrubbed-up assistant towels the perineal region and passes a long pair of sponge-holding forceps through the anal canal into the pelvis The stay sutures on the rectum are fed to these forceps and carried down through the anus as the forceps are withdrawn. By traction on these sutures the ano-rectal remnant is turned inside out and tissue forceps can be applied to the cut edge in its everted position outside the anus



Delivery of colon stump through anus

21 Stay sutures are next inserted in the end of the colon stump and the Parker Kerr clamp removed from it. These sutures are similarly guided through the anus and the colon stump is cautiously drawn down inside the everted anorectal stump till the cut edges of the two stumps lie opposite one another outside the anus.



The anastomosis

22 This is performed by the perineal assistant. Four mattress sutures of No 0 chromic catgut are inserted at north, south, east and west positions. Whilst the tails of these sutures are held taut the apposition of the edges of the rectum and colon is completed by a continuous fine chromic catgut stitch extending circumferentially round the lumen.

Replacement of anastomosis in pelvis

23 The stay sutures are cut and the anastomosis is allowed to recede through the anus inside the pelvis. The result is that the patient is left with a very low intrapelvic colo-rectal anastomosis with a well inverted suture line.

Drainage of pelvic cavity suture of pelvic peritoneum

The abdominal operator now places an extraperitoneal suprapubic drain down to the site of the anastomosis and sutures the pelvic peritoneum over it as in anterior resection (*see above* Illustration 16) It is always wise to provide a temporary defunctioning transverse colostomy in conjunction with abdomino-anal resection. The abdominal wound is then closed in layers.

SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

Parenteral antibiotic therapy with penicillin 500 000 units thrice daily and streptomycin 500 mg 6-hourly is continued for 7–10 days. Oral fluids should be restricted and the intravenous infusion continued till vigorous peristalsis returns and flatus or motion is passed per anum or per colostomy glycerine suppositories may assist to that end. The suprapubic drain is retained for at least 7 days to form a track to the surface and the urethral catheter continued for 4 or 5 days

If a transverse colostomy was provided and was not closed at the time of the resection this is now done by an intra-peritoneal or extra-peritoneal technique 10–14 days after the operation provided that no septic complications have occurred.

Breakdown of bowel suture line and formation of suprapubic faecal fistula

Separation of the anastomosis at some part of its circumference, usually the posterior third, occurs in approximately one case in 6 treated by anterior resection, and slightly more frequently in patients treated by abdomino-anal resection. A suprapubic faecal fistula develops in roughly half of the cases so complicated. Usually it dries up spontaneously in 10–14 days, but in some cases a temporary transverse colostomy is necessary to induce it to close.

Pelvic abscess

This is rare usually it bursts into the rectum and thereafter quickly resolves. Occasionally it discharges into the vagina, but if a defunctioning transverse colostomy is established a persistent recto-vaginal fistula does not result.

Diffuse peritonitis

This is also most uncommon and liable to be confused with a simple paralytic ileus. It calls for the most energetic therapy with intravenous aureomycin erythromycin or other appropriate antibiotic.

Incontinence

After anterior resection the functional result is practically invariably excellent, though due to the loss of the greater part of the sigmoid colon motions are passed more frequently This rectifies itself in a few months. After abdomino-anal resection, if care is taken to preserve at least 2 inches of ano-rectal mucosa, normal continence is also usually achieved, but the patient may be unsure of his control at first, especially for liquid motions or flatus. After 6 months or so however anal function becomes satisfactory though there may be 3 or 4 motions in the day

Stricture

Provided that the patient is not left for several weeks with a defunctioning colostomy serious stenosis seldom develops at the site of anastomosis, for normal semi-solid faeces are a most effective dilator

Local recurrences and fresh primary carcinomas

A recurrence of the original growth or a fresh primary neoplasm sometimes develops in the region of the anastomosis or in the rectal stump These further manifestations may occasionally be removable by abdomino-perineal excision but this may be technically a very difficult operation.

[The illustrations for this Chapter on Resections for Rectal Cancer were drawn by Miss Mary D Brown]

Bibliography

Babcock, W W (1932) *Surg Gynec Obstet.*, 55, 627

Bacon, H. (1945) *Surg Gynec Obstet.*, 81, 118.

Goligher J C., Dukes, C. E and Bussey H. J R. (1951) *Brit J Surg.*, 39 8.

Judd, E S., and Bellegie (1952). Arch. Surg., 64 697

Maunsell, H. W (1892). *Lancet*, 2, 473

Waugh, J M., Miller E. M., and Kurzweg, F T (1954). *Arch. Surg.*, 68, 469

Weir R. F (1901). *J Amer med. Soc.*, 37 801

PART V

THORAX

PART V THORAX

BRONCHOSCOPY

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PRE-OPERATIVE

Indications

Diagnostic bronchoscopy is indicated when it is necessary to obtain information about the condition of the larynx, trachea, major bronchi and their larger subdivisions by direct examination—this may include the taking of biopsy specimens. Information about conditions of the lungs may be obtained by the observation and examination of secretions or washings emerging from lobar or segmental bronchi. Disease of other intrathoracic organs may show itself by spread into the walls of the bronchi.

Therapeutic bronchoscopy may be called for to remove foreign bodies or excessive secretions from the bronchial tree. Certain tumours projecting into the bronchus may be removed through the instrument in selected cases, but it is important to note that the routine treatment of bronchial adenomas by endoscopic resection is *not* advised. Bronchoscopy is also necessary for the insertion of some types of endo-bronchial blockers used in general anaesthesia.

Special contra-indications

Advanced arthritis of the spine may make the examination impossible. Bronchoscopy is contra-indicated except in a grave emergency in the presence of a full stomach, particularly if local anaesthesia is to be employed. It is also unwise if oral sepsis is present. The examination is dangerous in cases with enormous intrathoracic tumours or aneurysms.

Special equipment

A good sucker is essential and a suitable laryngoscope may facilitate the introduction of the bronchoscope in tiny infants. Small swabs wrung out in 1/1 000 adrenaline are useful to stop troublesome bleeding after taking biopsy specimens.

Pre-operative preparation

Oral sepsis should be treated prior to the examination if possible

Anaesthesia

Local anaesthesia with previous premedication with Nembutal, Omnopon, and atropine is best for adults, but general anaesthesia is desirable for infants and young children. In some centres general anaesthesia is preferred even for adults.

Position of patient

The procedure may be carried out with the patient either in the sitting position (for example in a dental chair or in bed in urgent cases) or supine on a table. A special bronchoscopy head support on the table is desirable but not essential. The patient's cervical spine should be moderately but not excessively extended and the head including the eyes covered with a towel.

THE OPERATION

Identification of the uvula

1 The operator stands behind the patient's head. The upper incisor teeth are protected by a moist swab and the beak of the bronchoscope is passed over the dorsum of the tongue keeping strictly to the middle line the uvula being identified at this stage.

Passing the epiglottis

2 The proximal end of the instrument, held in the fingers of the right hand like a pen is then swept gently backwards towards the operator and the beak advanced until the tip of the epiglottis is seen. The beak is then advanced over the back of the epiglottis which is lifted forwards by the use of the left hand holding the bronchoscope just outside the mouth. The larynx and vocal cords will then come into view The inexperienced operator may find it easier to pass the instrument, in the case of an infant, if the larynx is viewed with a laryngoscope and the bronchoscope then passed into the larynx through the laryngoscope

Advancing to the carina

3 The instrument is insinuated between the vocal cords during inspiration and advanced steadily down the trachea until the carina is seen in the middle line Increased extension of the patient s spine will probably help at this stage.

Entry of the main bronchus

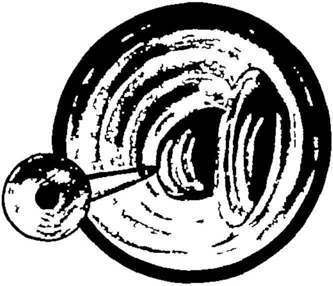
4 The instrument is then passed into whichever main bronchus is desired, at the same time moving the patient s head towards the opposite side and rotating it slightly laterally The entry of the upper lobe bronchus will be found on the lateral side of the main bronchus, it being remembered that the right main bronchus is shorter than the left.

Other bronchial orifices

5 Steady advancement of the instrument will then bring the other bronchial orifices into view—the middle lobe bronchus on the right side being situated anteriorly and the apical segmental bronchus of the lower lobe posteriorly. Finally the orifices of the basic segmental bronchi will be seen. It may be necessary to raise or lower the patient's head during these manoeuvres in order to obtain a clear view of a particular area.

Viewing interior of main branches of bronchial tree

6 A right-angle view telescope may be passed down the lumen of the bronchoscope to obtain a view of the interior of the main branches of the bronchial tree. The beak of the bronchoscope is held just proximal to the bronchus to be inspected and the telescope then passed. The direction of the visual field is shown by the projection on the rim of the eye-piece and suitable movement of the telescope will bring into view the field required.



Taking biopsy specimens

7 A biopsy specimen may be taken from any area that can be brought into direct view by means of suitable forceps passed down the lumen of the bronchoscope If troublesome oozing persists after the taking of a biopsy it can usually be stopped by pressure of a swab wrung out in 1/1 000 adrenaline. All blood should be sucked out of the bronchial tree before removing the bronchoscope otherwise troublesome pulmonary atelectasis and infection may follow

Removal of foreign bodies

8 Foreign bodies aspirated into the bronchial tree may be removed in most cases with the aid of suitable forceps passed down the bronchoscope. The position and nature of the foreign body should be ascertained with the greatest care before attempting the actual removal.

SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

The patient should be nursed in the semi-prone position with the head low and with the healthy lung uppermost, particularly if there has been significant oozing following the taking of a biopsy or if excessive secretions are present. This position should be maintained until a vigorous cough reflex returns.

No food or drink should be allowed for 8 hours after the procedure if this has been done under local anaesthesia for fear of aspiration of material into the larynx and bronchial tree.

Haemorrhage

Severe bleeding may follow the taking of a biopsy from a vascular adenoma and some surgeons advise against taking such a biopsy if the diagnosis seems clear from the macroscopic appearance of the tumour In the great majority of cases, however even brisk bleeding can be controlled by the pressure of an adrenaline-soaked swab on the area concerned. If some oozing does persist post-operatively treatment by the administration of a barbiturate to allay anxiety and the adoption by the patient of a suitable posture to encourage free drainage from the affected area is all that is required.

Pulmonary collapse and infection

These are usually the result of the aspiration of blood or infected secretions and should be prevented by the means mentioned previously If they do occur treatment by the administration of antibiotics and vigorous physiotherapy to encourage the emptying of the affected area should be started without delay

Oedema of the larynx

This may occur following careless instrumentation particularly in children if too large an instrument has been used. The use of the old fashioned steam kettle or tent will probably tide the patient over a dangerous period but tracheotomy should not be delayed if signs of respiratory obstruction increase.

[*The illustrations for this Chapter on Bronchoscopy were drawn by Mr J Wheldon.*]

Bibliography

Brock, R. C. (1934) *Anatomy of the bronchial tree* London Oxford University Press.

Jackson, C., and Jackson, C. L. (1946). *Diseases of the nose throat and ear* Pages 597–609 730–739. London Saunders.

OESOPHAGOSCOPY

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PRE-OPERATIVE

Indications

Diagnostic oesophagoscopy is indicated when it is necessary to obtain information about the condition of the oesophagus by direct examination

Therapeutic oesophagoscopy may be required for such purposes as the removal of foreign bodies, dilatation of a stricture insertion of a Souttar s tube, treatment of achalasia of the cardia with the hydrostatic dilator or the injection of oesophageal varices.

Special contra-indications

These are similar to those given in the Chapter on Bronchoscopy (*see* Part V page 5)

Special equipment

A powerful sucker with a large-bore tube is required, particularly in conditions of chronic obstruction, as it may be necessary to remove much debris before an adequate examination can be made. A bladder syringe makes a useful irrigator If an examination of the lower oesophagus and cardiac sphincter is to be carried out, it is important to make sure that the oesophagoscope is of adequate length—many standard types of oesophagoscope are too short for this purpose

Pre-operative preparation

Oral sepsis should be treated prior to the examination if possible

Anaesthesia

Local anaesthesia with previous premedication with Nembutal, Omnopon, and atropine is satisfactory for most cases in adults and is particularly suitable when it is necessary to obtain information about the function of the cardiac sphincter If this special information is not required general anaesthesia given through an endotracheal tube is more comfortable for the patient. General anaesthesia is indicated for children and infants.

If general anaesthesia is used, it is important in cases of chronic oesophageal obstruction to be ready to deal at once with material which may be regurgitated from the oesophagus into the larynx during the induction. A complete bronchoscopy set should be immediately available to aspirate the bronchial tree if required.

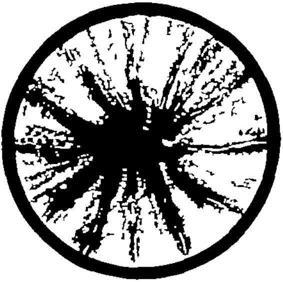
Position of patient

Positions similar to those mentioned in the Chapter on Bronchoscopy (Part V page 5) are satisfactory care should be taken to avoid excessive extension of the patient s cervical spine as this tends to increase the risk of perforation of the pharynx or upper oesophagus. In cases of difficulty in examination of the lower oesophagus help may be obtained by placing the patient in the lateral position.

THE OPERATION

Introduction of the oesophagoscope

1 The oesophagoscope is introduced in exactly the same way as the bronchoscope until the epiglottis and the arytenoids come into view The tip of the instrument is then made to deviate from the middle line and to pass into the right pyriform sinus lateral to the right arytenoid cartilage. After the tip has advanced 2 or 3 cm. it is brought back to the middle line and at the same time the larynx is lifted forwards. It is important to avoid pressure on the posterior wall of the pharynx. The region of the crico-pharyngeal sphincter will now come into view and if the examination is being performed under general anaesthesia the sphincter will probably be relaxed and the oesophagoscope can be passed readily into the oesophagus. If local anaesthesia is being used the sphincter can usually be made to relax by asking the patient to swallow The greatest care should be used if a pharyngeal pouch is present as it is very easy to pass the instrument into the pouch and difficult to find the real lumen of the oesophagus.



Removal of debris

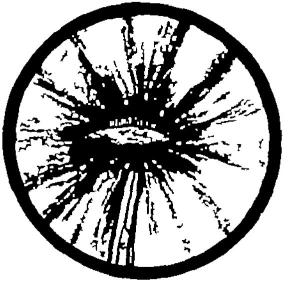
2 The instrument can now be passed steadily down the oesophagus, the patient's spine being further extended if necessary In obstructive conditions the lumen may be filled with much debris which should be removed through a wide bore sucker tube assisted by copious irrigation if necessary Large fragments may have to be removed with suitable forceps.

Taking biopsy specimen

3 The instrument can be passed down to the cardiac orifice of the stomach in most cases without difficulty Information about the action of the sphincter mechanism can be obtained by watching its movements during deep inspiration and expiration if the patient is under local anaesthesia. The presence or absence of gastric reflux should be noted. In most cases the tip of the instrument can be passed into the stomach itself and the typical gastric mucosa observed. Movement of the patient's head to the right usually makes this last stage easier If a biopsy specimen is required it can be taken with long forceps from the area being examined.

Removal of foreign bodies

4 Foreign bodies impacted in the oesophagus may be removed via the oesophagoscope with suitable forceps. The greatest care must be used to avoid laceration of the wall of the oesophagus. In this connexion version of the impacted foreign body may be valuable—the unimpacted end being grasped with the forceps leaving the opposite sharp end to trail behind. In rare cases it may even be necessary to divide some impacted foreign bodies if further damage is to be avoided.



SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

No food or drink should be taken for 8 hours after the procedure if it has been undertaken under local anaesthesia for fear of aspiration of foreign material into the bronchial tree.

Perforation of pharynx or oesophagus

Accidental perforation usually occurs in the region of the crico-pharyngeal sphincter but may occur lower down the oesophagus, particularly following the passage of bougies in cases of stricture or the removal of foreign bodies. If the condition is recognized at once the region of the laceration should be exposed by open operation and treatment by suture of the laceration or immediate resection of the damaged area and the underlying pathological condition (for example, simple or malignant stricture) carried out if possible.

Acute mediastinitis

This usually follows perforation of the oesophagus, which may not have been recognized at operation, but in a few cases may follow damage to the wall of the oesophagus without frank perforation. Treatment by the administration of antibiotics and the avoidance of oral feeding for some days is often successful, but surgical treatment may be required.

Pneumothorax and surgical emphysema

These result from perforation of the oesophagus and treatment of the underlying condition is required.

[The illustrations for this Chapter on Oesophagoscopy were drawn by Mr J Wheldon]

Bibliography

Jackson, C., and Jackson, C. L. (1946) *Diseases of the nose throat and ear* Pages 670–787 789–762. London Saunders.
Smith, C. C., and Tanner N C. (1956). "The Complications of Gastroscopy and Oesophagoscopy" *Brit. J Surg.*, **43**, 396–403

THORACOSCOPY AND DIVISION OF ADHESIONS

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PRE-OPERATIVE

Indications

Thoracoscopy may be used as a method of diagnosis to inspect the pleural surfaces, either visceral or parieta More commonly it is indicated in the treatment of pulmonary tuberculosis by artificial pneumothorax when ' relaxation of the lung is imperfect on account of pleural adhesions. The relaxation can often be improved by of these adhesions if conditions are suitable.

In certain cases of benign spontaneous pneumothorax help is obtained by thoracoscopy and where it is ' that the perforation of the lung is situated at the root of an adhesion and is being held open by this adhesior division of the adhesion often allows the lung to relax and the leak to seal itself off.

Special contra-indications

The inability to induce an artificial pneumothorax is an absolute bar to thoracoscopy It is also contra-i ' tuberculous cases in the presence of recent, active disease. The presence of appreciable fluid in the pleural ca or the finding of active-looking tubercles on the surface of the lung or pleura at thoracoscopy makes division adhesions inadvisable. An adhesion overlying a large thin-walled tuberculous cavity should not be divided fc fear of later rupture of the cavity due to necrosis from loss of blood supply which had been passing in the " Division of adhesions is inadvisable where they are found to be short or unduly numerous. Proximity to anatomical structures may also contra-indicate division.

Special equipment

For most purposes the ordinary right-angle view thoracoscope and separate cautery electrode for division adhesions is advised. Some operators, however prefer the foroblique thoracoscope and some the single o thoracoscope in which the optical and cutting systems are combined in one instrument and can be through a single cannula in the chest wall. Facilities for thoracotomy should be available to deal with injury to large intrathoracic vessels during the procedure.

Pre-operative preparations

An artificial pneumothorax should be induced prior to the actual procedure. The axilla should be shaved tog with the whole chest if hair is present.

Anaesthesia

Local anaesthesia is entirely satisfactory after adequate premedication.

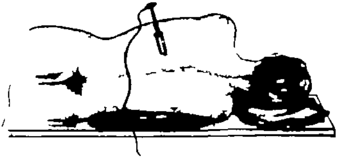
Position of patient

The patient is placed in the lateral position with the affected side uppermost and with a small pillow b the underside to widen the rib spaces where the cannulas are to be introduced. The scapula should be drawn forward.

THE OPERATION

Introduction of thoracoscopy cannula

1 The site for insertion of the thoracoscopy cannula is decided after careful study of the radiographs has shown the lung to be free at the proposed site. A usual site is the fifth or sixth intercostal space about 4 inches from the middle line posteriorly The chest wall is anaesthetized down to the pleura with local anaesthetic and a ½-inch long skin incision is made with a scalpel It is wise to confirm the presence of a free pleural space at the site by the insertion of a needle and stilette into the pleura. The trocar and cannula are then inserted by firm steady pressure, the trocar removed and replaced by the thoracoscope. A thorough inspection of the pleural cavity is then made and the presence, position, and type of adhesions, if any carefully noted.



Introduction of cautery cannula

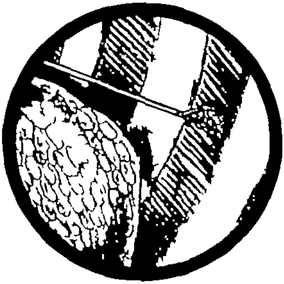
2 If adhesions are to be divided a second trocar and cannula are introduced in the same way at a site which will be convenient for manipulation of the cautery A usual site is the third intercostal space in the mid-axillary line. The cautery is then adjusted to a dull red heat, cooled and passed through the cannula until it is seen entering the pleura by the operator looking through the thoracoscope.

Division of adhesions

3 Keeping the cautery tip under observation the whole time suitable manipulation will bring it into proximity with the first adhesion to be divided The heating current is then turned on and the adhesion divided If of appreciable width the band should be cut step by step and any oozing points on the parietal end touched with the cautery Other adhesions are then dealt with in a similar way if necessary *No* adhesion should be divided if there is the slightest risk of damage to important mediastinal structures or to the lung After adhesion section has been completed the cautery cannula is removed and the skin wound closed with a stitch. In the case of the second cannula the skin stitch is tied at the end of a full expiration as the cannula is being removed—the stitch having been placed while the cannula is still in position.

Taking a biopsy specimen

4 If it is thought necessary to take a biopsy specimen from the pleura for diagnosis this can be done under direct observation by passing a long pair of special biopsy *forceps* through the second cannula to the area under view through the thoracoscope.



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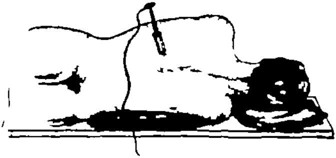

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SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

After the procedure the patient should be on the non-operated side for the first few days. It is important that the patient be kept quiet and cough suppressed as far as possible for a day or so post-operatively otherwise the air from the pneumothorax may be driven out of the pleural space along the wound tracks into the tissues. Injections of Omnopon and a sedative linctus may be required for this purpose. A chest radiograph should be taken with a portable machine on the days following the operation in order to make sure the pneumothorax space is not lost. Refills of air should be given as required to maintain a good pneumothorax.

Surgical emphysema

Some degree of post-operative surgical emphysema is common but is not usually severe and no special treatment is required.

Haemorrhage

Some oozing into the pleural cavity may follow the division of adhesions. Treatment by sedation of the patient and aspiration will usually be all that is required. If severe bleeding should occur post-operatively it may be possible to arrest it by inserting two cannulas into the chest again, removing blood and clot with a powerful sucker and coagulating the bleeding vessel with the cautery If this fails thoracotomy and ligature of the bleeding point is indicated and blood transfusion will certainly be required.

Pleural effusion

This should be watched for carefully and treated by aspiration if the fluid is non-purulent. If the fluid shows signs of becoming purulent there is grave danger of a tuberculous empyema developing and in the author's opinion the artificial pneumothorax should be abandoned without delay

Rupture of tuberculous cavity

This should never occur if care is taken only to divide adhesions when the procedure is strictly indicated and no contra-indications are present. If rupture does occur it will show itself by signs of pleural infection and possibly of a tension pneumothorax developing Radiographic evidence will also help in making a diagnosis. Treatment by immediate resection of the diseased portion of lung must be considered but if thought impossible, closed drainage of the pleural cavity is urgently required.

[The illustrations for this Chapter on Thoracoscopy and Division of Adhesions were drawn by Mr J Wheldon.]

Reference

Alexander J *The Collapse Treatment of Pulmonary Tuberculosis.* Baltimore: Charles C. Thomas.

ASPIRATION OF THE PLEURAL AND PERICARDIAL CAVITIES

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PRE-OPERATIVE

Indications

Aspiration of these cavities may be undertaken either for diagnosis or treatment, and may be called for after an injury to the chest or following thoracotomy when air or fluid is present in either cavity There may be particular urgency in the aspiration of a traumatic haemopericardium where tamponade is present. Aspiration is often indicated in acute and chronic infections, notably empyema thoracis and tuberculous pleural effusion, and in pulmonary neoplasms where an effusion is present.

Continuous aspiration of air may be necessary in the case of a spontaneous or tension pneumothorax where there is a persistent air leak from the lung Relief of a tension pneumothorax may be a matter of very great urgency

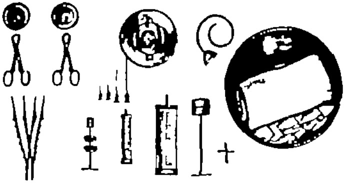
Contra-indications and anaesthesia

There are no special contra-indications to these procedures. It should be emphasized that when performing an aspiration great care must be taken to observe strict asepsis. Local anaesthesia only is necessary 1 per cent procaine being a suitable agent. A small intradermal wheal is raised with a fine needle at the chosen site. The needle is then changed to a long fine one and as this is advanced through the muscles of the chest wall and into the intercostal space, local anaesthetic is introduced. It is important to keep the needle towards the lower part of the space away from the neurovascular bundle which lies in the subcostal groove. When the parietal pleura is reached the patient may experience a sharp pain the slow advance of the needle is then stopped and 2 ml of local anaesthetic are introduced. The needle is then withdrawn. When infiltrating the parietes for a pericardial aspiration via the para-xiphoid route the patient may also experience pain when the parietal pericardium is reached and a similar quantity of anaesthetic should be injected into it.

TECHNIQUE

Equipment

1 Special equipment is illustrated. The success and comfort of an aspiration is largely dependent on the use of a good three-way stopcock, which must possess an adequate lumen, have a tap that can be moved without the application of force, and which does not leak.

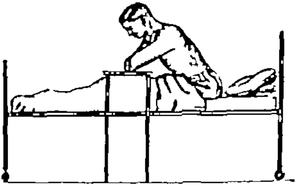


Pleural aspiration

Site of puncture and introduction of aspirating needle

2 The position for posterior aspiration is as illustrated. Two-plane radiological confirmation is advisable from which the horizontal level for the introduction of the needle is read off in terms of costal cartilages (often the best way in obese patients) a horizontal line may then be drawn round the chest and an appropriate rib space is chosen on this.

A few millilitres of the local anaesthetic solution are drawn up into the 20 c.c. syringe, the three-way stopcock fitted on, and then a suitable wide-bore aspirating needle is fixed to the distal end of the stopcock The rubber tubing is connected to the third outlet of the stopcock. The needle is then introduced along the track previously infiltrated with local anaesthetic and as the parietal pleura is approached very slight suction is applied to the plunger of the syringe Arrival in the pleural cavity is indicated when more fluid appears in the syringe. With some fluid already in the syringe it is easier to see and feel when the intrapleural collection is reached than if a dry syringe is used.



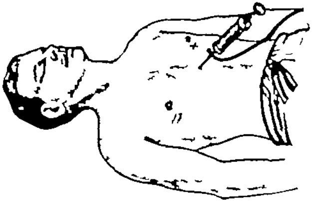
The withdrawal of fluid

3 This should be conducted steadily and slowly Spencer-Wells forceps will if required, secure the needle at the desired depth As a general rule in aspirations other than for diagnosis, as much fluid as possible should be removed in the case of a loculated effusion more than one puncture will be necessary Towards the end of the procedure it is found that fluid enters the syringe in a jerky fashion coming most easily on expiration—a sign that the amount of fluid remaining is small. It is highly important that air should not be introduced into the chest by leakage at the joints in and around the stopcock.

Pericardial aspiration

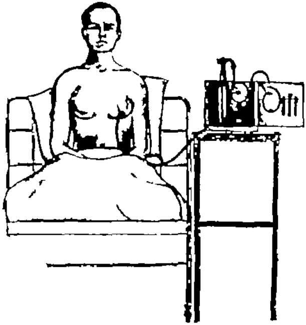
4 The equipment used is as for pleural aspiration the patient lying flat. The best site for aspiration is alongside the xiphoid process, the needle being directed at an angle of 45 degrees upwards and backwards. An increased resistance can be felt when the parietal pericardium is reached and as the needle is further advanced it can be felt to pass through this membrane Pericardial effusions are most usually under some tension and comparatively little traction on the plunger is necessary Care must be taken not to advance the needle too far so as to impinge on the ventricular muscle or enter a ventricular cavity That this has occurred will be evidenced by increased movement of the needle and the very easy withdrawal of pure blood.

An alternative approach (x) is through the fifth left interspace, the needle being directed backwards and inwards. The internal mammary vessels run downwards 1·25 cm. from the edge of the sternum and must be avoided. The space should be punctured 5 cm. from the edge of the sternum for here there is little danger of injury to these vessels, also there is more certainty of obtaining fluid with this more lateral approach as the effusion in the pericardial sac usually has its greatest depth inferiorly and laterally rather than anteriorly



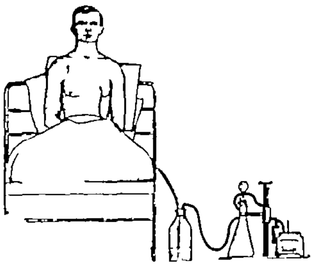
Management of a tension pneumothorax

5 When the patient is first seen and the condition diagnosed aspiration should be performed as a matter of urgency The second or third intercostal space, anteriorly in the nipple line is chosen as the site of insertion of a pneumothorax needle. This needle should be connected to a pneumothorax apparatus pressures are measured and air is then aspirated, pressures being measured from time to time. If a negative pressure is achieved and maintained for 2 minutes (during which time no more air is aspirated) the needle may be withdrawn.



Continuous aspiration

6 If however a positive pressure returns it is a sign of a continuous air leak. The needle must then be left in the chest (angulated so that it lies nearly parallel to the parietal pleura) and connected to an underwater seal. If the air leak is very large and is more than the needle can cope with, it is wisest to insert, under local anaesthesia, a rubber catheter into the pleural cavity via a trocar and cannula, again using the second or third space anteriorly This catheter is connected to an underwater seal and gentle suction (2 cm. Hg) applied to the air outlet of the underwater seal bottle. A channel for removal of air must be maintained until the leak stops and the danger of a tension pneumothorax is past.



[*The illustrations for this Chapter on Aspiration of the Pleural and Pericardial Cavities were drawn by Mr J Wheldon*]

INDUCTION OF ARTIFICIAL PNEUMOTHORAX

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PRE-OPERATIVE

Indications

Artificial pneumothorax is indicated in pulmonary tuberculosis where the amount of disease is slight, is relati recent and where healing can be expected to occur with very little scarring Induction must follow a period of l rest and chemotherapy The initial exudative phase of the disease should be arrested, as evidenced by apyrex lowered sedimentation rate a gain in weight and radiological signs of regression and hardening The indication the induction of an artificial pneumothorax in pulmonary tuberculosis have narrowed considerably in recent y as other forms of surgical collapse treatment have become available.

As a diagnostic measure there is indication occasionally for inducing a pneumothorax, where it is desirabl know if a non-inflammatory intrathoracic mass lies within the lung or arises from the chest wall subsequent ra graphs clarifying the situation.

It may be indicated to allow thoracoscopic examination of the pleural cavity

Very occasionally an attempt is made to induce a pneumothorax in order to test the result of a chemically indu pleurodesis.

Special contra-indications

Among contra-indications can be listed the following conditions exudative disease, extensive cavitation, ten cavities, tuberculous endobronchitis, lobar atelectasis, and pulmonary fibrosis.

Special equipment and apparatus

Lillingston and Pearson pneumothorax apparatus or a "dry apparatus, such as the Maxwell box, is neede well as an induction needle of the Rivière or Kuss type.

Pre-operative preparation

The patient may be sedated with Omnopon, $\frac{1}{3}$ gr 1 hour before the operation.

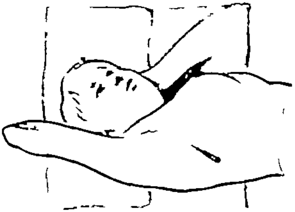
Anaesthesia

Local anaesthesia is satisfactory using 1 per cent procaine

Position of patient

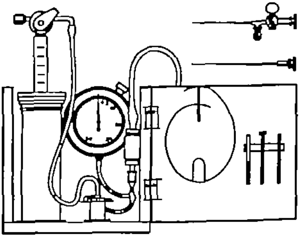
The patient should lie flat in bed on his side, with the diseased lung uppermost. A pillow should be placed ur the chest in order to open out the intercostal spaces. The upper arm is carried upwards and forwards so that lateral chest wall immediately below the axilla is exposed. This area is towelled after painting the skin with iodin.

THE OPERATION



Introduction of the local anaesthetic

1 Either the fifth or sixth intercostal space in the anterior axillary line is the site chosen. The local anaesthetic is introduced. A small intradermal wheal is raised and the needle then advanced, the injection being continued until the pleura is reached, when the patient may experience a little sharp pain It is important to ensure that the sensitive parietal pleura is well infiltrated. Approximately 4 ml. of the procaine solution are needed for the local anaesthetic.

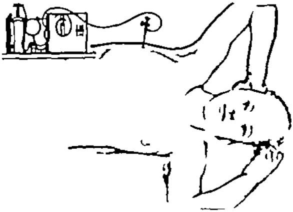


Introduction of the induction needle and assembly of the apparatus

2 A minute incision is made with a fine scalpel in the intradermal wheal. The Kuss needle is connected with the tubing of the Maxwell box, there being interposed a length of sterile rubber tubing and a glass connexion. The needle is then inserted through the skin puncture.

Passage of the needle

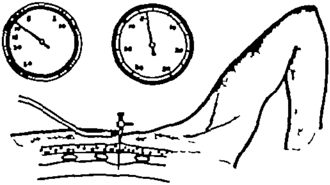
3 The needle is advanced through the structures of the intercostal space keeping towards the lowest part of the space in order to avoid injury to the intercostal vessels. After passing through the intercostal muscle and fascia, the trocar is withdrawn and the blunt stylet introduced as far as the tap on the needle the latter is now turned so as to open up communication between the lumen of the needle and the manometer



The needle is then advanced through the parietal pleura and a characteristic snap may be felt as it goes through. Fluctuation of the manometer should now be observed. A swing of the order of −10 −6 cm. of water being present on inspiration and expiration respectively Only when there is a satisfactory swing of the manometer is it safe to start introducing air Pressures of −2 +2 cm. of water usually means that the needle is within the lung and it should be withdrawn slightly the blunt stylet being then used to clear away any tissue blocking the lumen of the needle, until a satisfactory swing is shown. Failure to obtain a negative swing at all indicates that adhesions exist between the pleura and the underlying lung at the site of puncture. Another space should then be tried.

Introduction of the air

4 The piston of the Maxwell box is now pulled up so that the cylinder fills with air The tap on the piston rod is then turned and air is now introduced into the pleural cavity The piston may fall under its own weight, but if necessary a little pressure may be exerted on it. This must be very gentle. After 50 cc. have been run in, it is wise to stop the flow and read the manometer If a swing on the negative side is still present more air is introduced another check is made when 200 cc. have been put in.



For induction of an artificial pneumothorax 350 cc. of air is sufficient at the end of this there should be no positive swing of the manometer point except on a forced expiration The needle is now withdrawn.

SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

The patient should lie quiet and suppress any desire to cough for a few hours.

Refills are given on the first and third days after induction, and after this chest radiographs are taken, on expiration and inspiration to check the depth of the pneumothorax and to plan subsequent refills.

Air embolism is an extremely rare complication it is due to air having been introduced within the lung substance into a pulmonary vessel. The picture varies according to the amount of air introduced. If there is any faintness, giddiness, numbness or tingling of the limbs, the injection of air should stop at once and the head of the patient should be lowered.

Some surgical emphysema of the chest wall around the needle puncture is usual after induction but this is not troublesome.

It must be recognized that should extensive adhesions be revealed, should a cavity enlarge or should a large pleural effusion develop after induction, the artificial pneumothorax should be abandoned.

[*The illustrations for this Chapter on Induction of Artificial Pneumothorax were drawn by Miss P Wilson*]

Reference

Foster-Carter, A. F., *et al* (1932). *Brompton Hosp Rep.*, Vol. 21.

BRONCHOGRAPHY

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PRE-OPERATIVE

Indications

Bronchography is employed as an aid to diagnosis in many pulmonary conditions, particularly bronchiectasis. is of value in the differential diagnosis of carcinoma of the bronchus and pneumonitis. It is useful in certain types pulmonary tuberculosis where a knowledge of the detail of the bronchial anatomy is desired as a help in plannin excisional surgery

Special contra-indications

Very poor general condition of the patient, particularly those who have a markedly lowered respiratory reser The patient should be tested for iodine sensitivity before the procedure is undertaken.

Choice of method

For children a general anaesthetic is required, the radio-opaque medium being injected through a catheter pass down an endotracheal tube.

For adults there are three methods which can be used all are done under local anaesthesia. In the first the mediu is introduced into the oropharynx and is then inhaled in the second the oil is introduced down a catheter previous guided into the trachea and in the third the medium is injected directly into the trachea. The choice of method largely individual and is arrived at through the operator s familiarity with each technique. The pertracheal route the most certain method of getting a good bronchogram but it carries with it the risk of the later development of abscess in relation to the needle track, particularly in those patients with large amounts of purulent sputum. It therefore preferable to use one of the other routes for patients with more than one ounce of sputum a day

Special equipment

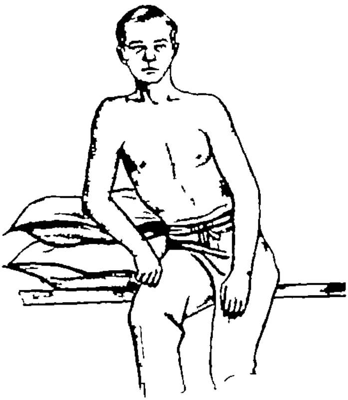
A curved metal cannula for attachment to a Record syringe and fitted at its tip with a small piece of rubb tubing is needed. For the pertracheal puncture short (1 inch) wide-bore, needles are required. The radio-opaq medium most commonly used is Lipiodol this has a slight disadvantage in that it takes many months to disappe from the lungs and may cause difficulties in later interpretation of films. More recently water-soluble preparatio such as Dionosil, have been used. This material disappears rapidly from the lungs

Pre-operative preparation

Sedation may be omitted in the case of an out-patient, but best results are generally obtained with the patie mildly sedated with $\frac{1}{3}$ gr Omnopon and $\frac{1}{150}$ gr scopolamine. If the patient has an excess of sputum it is mo important that a spell of tipping and coughing is done just prior to the procedure.

Bilateral examination

As a rule the side most suspected should be done first but where both sides are under review it is wisest to do t right side first and then the left. In all cases the procedure is carried out in the x-ray room.



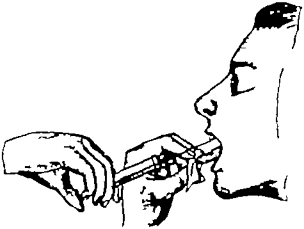
THE OPERATIONS

PERORAL BRONCHOGRAPHY

Position of the patient

1 The patient is seated on the x-ray table facing the operator

Local anaesthesia and introduction of the medium



2 An amethocaine lozenge is sucked just before coming to the x-ray department. Using the curved cannula mounted on a 5-cc. syringe, 8 ml. of 1 per cent amethocaine are now dripped slowly over the back of the tongue. A piece of gauze is wrapped round the tip of the tongue and the tongue is pulled forwards whilst the local anaesthetic is being introduced. This manoeuvre prevents swallowing, thus the crico-pharyngeal sphincter remains closed. The patient will cough during the introduction of the local but this is a good thing as it helps to spread the anaesthetic throughout the bronchial tree Two minutes are allowed to elapse before starting to introduce the contrast medium. The patient is now requested to restrain his probable desire to cough.

The patient now leans over to the side that is to be examined if the left side is being filled the patient's tilt must be more accentuated. Again with the tongue held well forward the medium is injected quite rapidly into the oropharynx. With the crico-pharyngeus closed, the medium spills into the laryngeal introitus and is then inhaled. The patient should be encouraged to breathe steadily but not too deeply and not to make any coughing or swallowing efforts. About 30 seconds are taken to inject the medium for an average sized adult 12 ml. will be sufficient.

Positioning of the patient

Position 1

3 For either side the positioning drill is the same

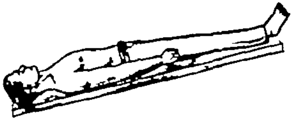
The basal segments will fill during injection of the oil. Immediately the injection is finished the patient lies on his side the head supported by one pillow This position is held for 10 seconds and should effect upper lobe filling

Position 2

4 The patient is then turned fully on to his face and kept in this position for 10 seconds this should effect filling of the middle lobe or lingula, and of the anterior segments of the upper and lower lobes.

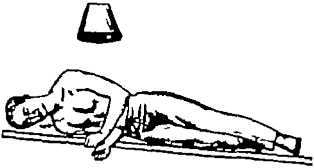
Position 3

5 He is now turned on to his back, the x-ray table is angled to give a 15-degree Trendelenburg tilt: this should effect filling of the apical segments of the upper and lower lobes.



Position 4

6 The patient is now turned on to his side, and the table is now given a 10-degree reverse Trendelenburg tilt. It is important that these changes in position should be carried out smoothly and without delays it is not thought necessary that the chest should be screened at any time during the examination. From the moment of starting to introduce the medium into the mouth to completion of the x-rays need not take more than 8 minutes. X-rays are taken—lateral, oblique and antero-posterior views.



TRACHEAL PUNCTURE

Position of the patient

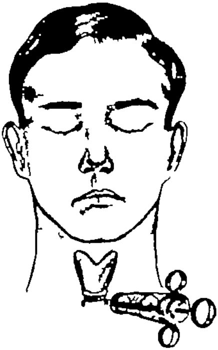
The patient's position is as for peroral bronchography seated on the x ray table facing the operator The neck is now fully extended.

Local anaesthesia

A small subcuticular wheal is raised with 1 per cent procaine in the front of the neck, in the midline just below the cricoid cartilage. Taking another syringe containing 2 ml. of 2 per cent amethocaine the needle is advanced into the trachea. The amethocaine is then injected very rapidly and the needle withdrawn. The patient will experience a fit of coughing but this will stop within 30 seconds. Positioning of the patient is as already described.

Injection of the oil

7 The trachea is punctured with the special needle fitted to a syringe containing 12 ml. of radio-opaque oil. Certainty that the needle point lies within the lumen of the trachea is afforded by being able to withdraw air into the syringe. The patient is now tilted to whichever side is to be examined. The oil is then injected steadily and fairly quickly The needle and syringe are then withdrawn it is not recommended that the needle be kept in position whilst posturing is being done and films taken. If the other side is to be done at the same sitting it is preferable to perform another puncture



SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

After the x-rays are developed and are judged to be satisfactory the patient is tipped 20 degrees head down and allowed to cough up as much of the medium as he can. This immediate tipping is helpful in clearing the oil from the lung and should be continued when the patient returns to the ward or to his home.

The patient is allowed nothing to eat or drink for 4 hours following the examination to allow time for the local anaesthetic to wear off

The possibility of an iodine reaction must always be considered.

[The illustrations for this Chapter on Bronchography were drawn by Mr J Wheldon]

PHRENIC NERVE CRUSH

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PRE-OPERATIVE

Indications

Phrenic nerve crush may be indicated in cases of pulmonary tuberculosis particularly for cavities situated in the lower lobe A pneumoperitoneum is usually induced and maintained as an adjunct to the diaphragmatic paralysis. Besides increasing the height of the rise of the diaphragm and thus the degree of relaxation of the lung a pneumoperitoneum supports the diaphragm and by maintaining it in an elevated position, prevents, to some extent, harmful paradoxical movement.

Phrenic crush may be indicated in certain cases of emphysema. Also it may be of value following lobectomy or pneumonectomy whether for tuberculosis, cancer or bronchiectasis, when it is desired to reduce the size of the hemithorax in order to prevent too excessive mediastinal shift, or to prevent overdistension of remaining lobes.

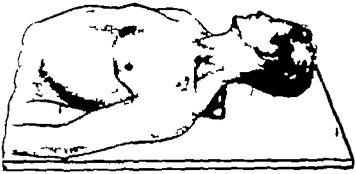
Anaesthesia

Local anaesthesia, using 1 per cent procaine is most satisfactory General anaesthesia is unnecessary

THE OPERATION

Position of the patient

1 The patient lies supine and a low pillow is placed between the shoulder blades. The patient's head is turned to one side thus exposing the antero-lateral aspect of the neck on the operation side. The arm of the patient on this side should be stretched downwards, thus dropping the outer end of the clavicle and making the sterno-mastoid muscle on that side more prominent.

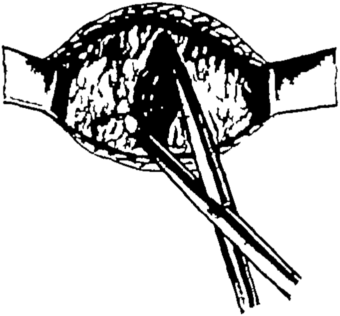


Injection of local anaesthetic

2 The scalenus anterior muscle can be palpated in the floor of the triangle formed by the posterior border of the sterno-mastoid muscle medially the clavicle inferiorly and the external jugular vein posteriorly The phrenic nerve lies on the superficial aspect of the scalenus anterior in this situation. Local *anaesthetic is introduced superficially* and deeply in this triangle. The incision is made 1½ inches long 1 inch above the middle third of the clavicle. The platysma is divided and the posterior border of the sterno-mastoid muscle identified.

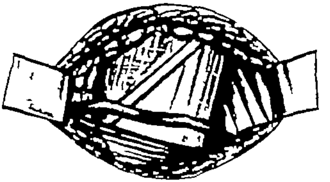
Further exposure

3 A retractor preferably illuminated is placed deep to the posterior border of the sterno-mastoid and is held by an assistant. A second retractor is held in the operator's left hand and by blunt dissection with the points of a pair of Dunhill's forceps the incision is deepened. The retractors are gradually placed more deeply parting the loose fatty areolar tissue that lies superficial to the scalenus anterior muscle The omohyoid muscle and the transverse cervical artery are frequently encountered these may be partially mobilized from the areolar tissue in which they lie and held aside by the medial retractor



Identification of the nerve

4 The nerve will be found lying on the superficial aspect of the scalenus anterior lying deep to the prevertebral fascia which is usually well developed in this situation. The fascia should not be disturbed and it is not necessary to dissect the nerve further or pick it up with a hook.



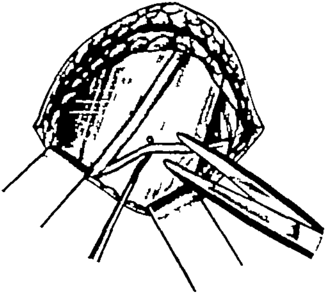
Crushing the nerve

5 The nerve should be crushed as it lies deep to the prevertebral fascia. The importance of leaving this fascial layer intact is stressed as should the operation be advisable on a second occasion after recovery of movement of the diaphragm, its anatomical relations have been relatively undisturbed and it is therefore not difficult to find again. The crush should be carried out with an extremely light haemostat and should be a pinch rather than a crush. Crushing in one place only is advised multiple crushes or too forceful a crush is likely to result in permanent paralysis. A jump of the diaphragm will be observed at the moment of crushing the nerve and the patient may experience pain in the shoulder

Search for accessory branches

6 Occasionally the contribution of the nerve from the fifth cervical root joins the main trunk lower down behind the clavicle and it is wise in all cases to shift the position of the retractors in order to expose the scalenus anterior at a lower level. The accessory branch, when present, will be recognized as a fine nerve passing from lateral to medial to join the main phrenic trunk. It is best to divide this nerve rather than to crush it, as then it need not be searched for again should a recrush be advisable at a later date.

The wound is closed in two layers, the divided platysma being approximated by fine catgut sutures and clips being placed in the skin.



SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

The operator must be aware of the possibility of mistaking the brachial plexus branches, the vagus nerve or the sympathetic chain for the phrenic nerve. The most careful identification of the scalenus anterior is important if the medially directed course of the phrenic nerve is then remembered, accidental crushing of other structures will be avoided.

The patient should be fluoroscoped immediately after leaving the operating theatre to check that a satisfactory paralysis has been achieved. If the diaphragm still shows active movement the patient is then brought back to the theatre and the wound re-explored, search being made for other accessory branches.

The most effective rise in the diaphragm is obtained if the patient is subsequently nursed with the foot of the bed elevated on 6-inch blocks. This posture can be maintained for a week or longer if required. Avulsion of the phrenic nerve is a procedure which is no longer practised.

[The illustrations for this Chapter on Phrenic Nerve Crush were drawn by Mr J Wheldon]

Bibliography

Berry F B (1930). *Arch. Surg.*, **21**, 1125
O'Shaughnessy L., and Crawford, J H. (1936). *Lancet*, 1, 694.

SURGICAL ACCESS TO THE CHEST

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PRE-OPERATIVE

GENERAL

Introduction

There are many reasons why it is difficult to systematize the thoracic approach. Chest surgery is still in many ways in its evolution, and the absence of a firm tradition leads to many individual preferences and modifications. There is sometimes a need for multiple approaches during one operation while the combined access to chest, abdomen and/or neck may be necessary. Nevertheless, several so-called "standard approaches" have emerged.

The surgeon is concerned both with obtaining adequate access to particular parts of the thoracic cavity, and with room for manoeuvre, not always synonymous terms since the lung is a very space-occupying and mobile organ. Sympathetic co-operation with the anaesthetist is thus a *sine qua non* for successful intrathoracic procedures.

Importance of patient's position on the table

Since the position of the patient on the table largely governs the approach and often has a bearing on the safety of the procedure, this method of classification has been adopted. A suitable table, with chest attachments capable of fixing the patient firmly, is necessary, while it is helpful to be able to move the patient during the operation by rotation and by raising and lowering the head.

The "wet" patient, who accumulates intrabronchial secretions during the operation with the risk of blockage of the airway and the spread of infection to the opposite side under gravity, is a special problem that has led to modifications of the standard table positions.

Pre-operative preparation

An adequate period of physiotherapy is essential. Apart from helping respiratory function the practice of respiratory movements will improve the general health and assist in the building up of the "solid" nutritional reserve. A period of postural drainage is advisable in patients with copious bronchial secretion.

Chemotherapy is required in the form of penicillin for 48 hours before operation, or in diseases like tuberculosis, for example, it may be necessary to give drugs for several weeks or months before surgery.

The need for careful assessment and correction of all nutritional deficiencies is emphasized.

Finally, bronchoscopy as an immediate pre-operative procedure should be performed routinely, for a final appraisement of the situation, for toilet of the bronchial tree and in some cases for the introduction of a bronchus "blocker".

Oesophagoscopy in patients with certain oesophageal lesions, particularly the obstructive ones, is equally important in order to remove accumulated infected materials and perhaps also to introduce a suitable "blocker".

Anaesthesia

Local anaesthesia is frequently used for minor chest-wall operations and even for major procedures like thoracoplasty by some surgeons, but for intrapleural operations general anaesthesia with controlled ventilation of the lungs is essential.

LATERAL THORACOTOMY

Lateral thoracotomy constitutes the commonest thoracic approach in use today It may be subdivided into the postero-lateral type and the postero-anterior type.

Indications

The approach is suitable for all pulmonary operations for certain cardiovascular procedures requiring access to one side of the heart, such as persistent ductus arteriosus, coarctation of the aorta and the Blalock operation for Fallot s tetralogy for posterior mediastinal operations, particularly when access to the oesophagus or the posterior part of the diaphragm is required.

Contra-indications

Other positions may be preferred for patients with abundant intrabronchial secretions because of the risk of spill-over into the opposite lung

ANTERO-LATERAL THORACOTOMY

Antero-lateral thoracotomy may be sub-divided into the upper and the lower approaches.

Upper Approach

This is indicated where limited access to the heart is required, for example to the left atrium (mitral valvotomy) right ventricle and its outflow tract, or the left ventricle.

Lower Approach

This approach is used usually on the left side in conjunction with a prolongation of the incision on to the abdominal wall for access to the lower oesophagus, the cardia and the upper stomach, the diaphragm and the abdominal organs in the left hypochondrium.

Used on the right side it will provide easy access to the liver the porta hepatis and other structures in the right hypochondrium.

ANTERIOR THORACOTOMY

Median Sternotomy

Median sternotomy is indicated where access is required to the thymus, aberrant thyroid or other anterior mediastinal structures or tumours.

Transverse Sternotomy

This may be used with extension into either or both pleural cavities and is indicated where access is required to the pericardium or to all chambers of the heart.

Left Anterior Thoracotomy

This is used for emergency exposure of heart—in acute failure" The only essential instrument is a scalpel

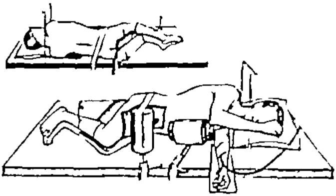
THE OPERATIONS

LATERAL THORACOTOMY

Position of the patient on the table

1 Attention is drawn first to the methods of firm fixation of the patient, since movement during the operation is undesirable secondly to the intravenous drip position and to the underlying axillary pillow which serves to facilitate thoracotomy by widening out the intercostal spaces on the operation side

Four towels are arranged, two parallel to the prepared skin incision, with one anterior and one posterior forming a rectangle A large abdominal sheet over the head of the table covers the anaesthetic screen and the intravenous drip apparatus, while a second large sheet covers a Mayo s tray and the remainder of the patient below the operation area.



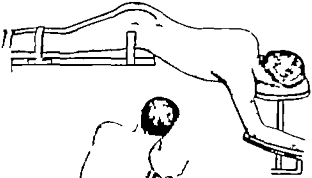
Special positions

In patients with copious bronchial secretions it may be advisable to use one of the following special positions on the table in conjunction with a lateral thoracotomy incision

For continuous postural drainage—the prone position

2 Overholt position

3 Sellors-Brown position.

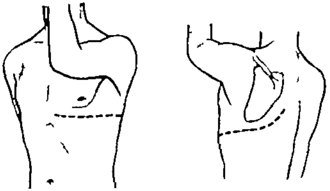


For continuous postural retention—the upright position

4 Galbraith-d Abreu position

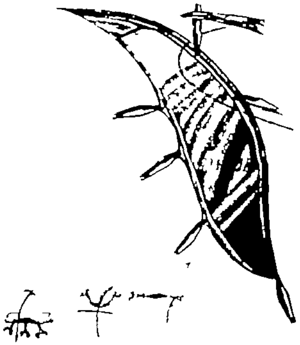
Skin incision

5 The postero-lateral incision begins in the anterior axillary line at the level of the sixth rib and extends backwards just below the angle of the scapula, turning upwards parallel to the vertebral border of the scapula and stopping about 1½–2 inches from the mid-line posteriorly If more exposure is required, then the incision may be extended farther forwards, even to the lateral border of the sternum—the postero-anterior type of incision.



Diathermy and placing of wound guards

6 All bleeding points are diathermed and the wound guards are clipped into place before the muscle incision is made



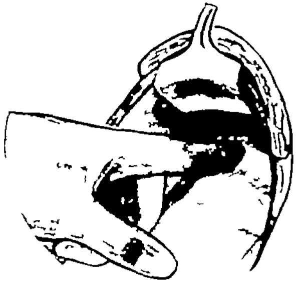
Exposure of the chest wall

Entrance to the muscle planes

7 This is made easier by defining a small fascial triangle behind the latissimus dorsi muscle and between it and the lateral border of the trapezius muscle, incising through it and the underlying rhomboid muscle until the chest wall is reached.

Excision of muscles

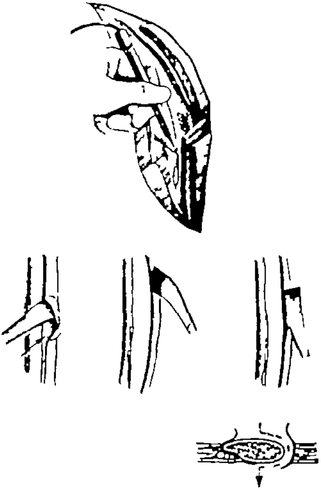
8 Using your assistant's and your own index finger to elevate the muscles, they are incised with diathermy parallel to the wound, picking up bleeding points meticulously as they are met in this way blood loss is reduced to a minimum.



Entry through the thoracic cage

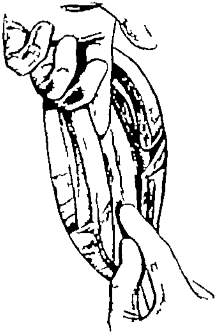
Selection of rib

9 The exact rib required is then defined by counting from above down under the elevated scapula. The rib chosen will depend on the projected operative procedure the fifth and the sixth are the more usual ones.



10 *Incision and eversion of periosteum*

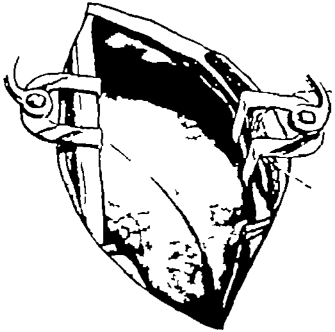
The periosteum is incised with diathermy in the mid-rib plane. The periosteum of the upper half of the rib is raised. In this way the intercostal neurovascular bundle is not interfered with.



11 *Entry into pleural cavity*

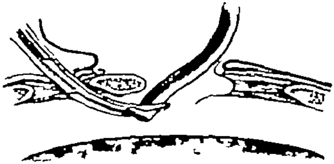
Entry into the pleural cavity is made by incising through the rib bed.

An intercostal incision is seldom employed today. Some surgeons still prefer to resect a rib sub-periosteally and rarely it is necessary to resect 1–2 inches of one or more ribs posteriorly as adequate access can always be gained by prolonging the incision forwards if necessary to the sternal border.



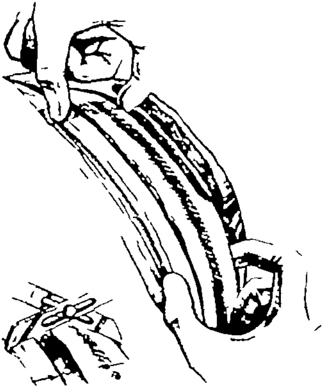
Introduction of retractor

12 Any adhesions in the neighbourhood of the incision between the chest wall and lung are divided so that a large self-retaining retractor of the Tudor Edwards or Price Thomas type may be introduced to spread widely the wound without tearing the lung



Drainage of the chest

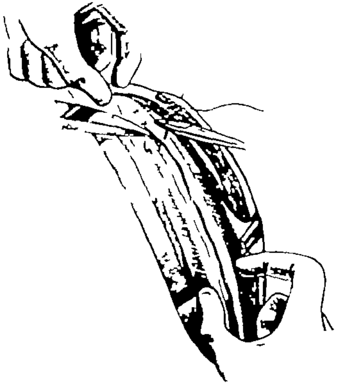
13 Depending upon the exact operative procedure it may be necessary to temporarily drain the pleural cavity usually for 48 hours after the operation. An intercostal tube is introduced immediately prior to closure and later is attached to an underwater seal drainage bottle



Closure of the wound

Approximation of chest wall

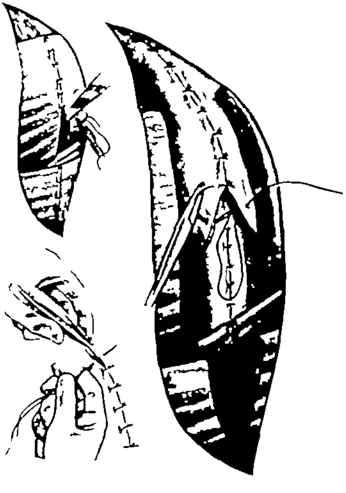
14 At the conclusion of the intrathoracic portion of the operation with the removal of the retractor manual approximation of the chest wall is usually an easy matter However in elderly subjects it is sometimes necessary to use instrumental approximation



Suture of periosteum

15 The periosteum is sutured with interrupted fine thread stitches at 0·5–1 cm. intervals.

A strong airtight closure able to withstand the explosive force of coughing is important it will prevent the collection of air and fluid within the layers of the wound.



Closure of muscles and skin

16 The muscles are closed in layers, all with interrupted fine thread sutures some surgeons prefer nylon or stainless steel wire.

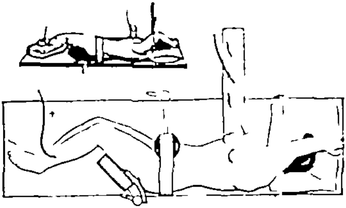
The skin is sutured with interrupted silk.

The tension of the sutures should be such as to only approximate the wound edges, thus allowing for oedema in the post-operative period without incurring the risk of necrosis around the stitches and secondary infection

ANTERO-LATERAL THORACOTOMY

Position of the patient on the table

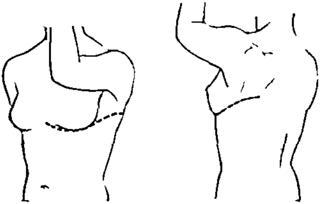
17 The pelvis is firmly fixed in exactly the same way as in the lateral chest position but the upper shoulder is allowed to rotate backwards for approximately 20 degrees, making the mid-sternal line easily visible and permitting the anterior towel edge to be fixed just to the right of it.



UPPER APPROACH

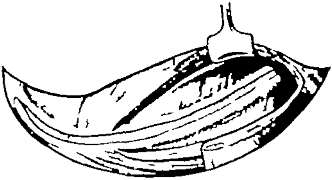
Skin incision

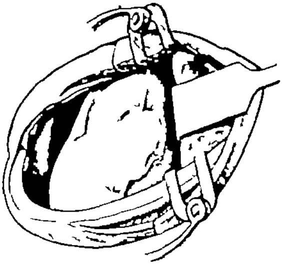
18 Beginning at the lateral border of the sternum, the incision runs in the submammary groove backwards and slightly upwards over the inferior angle of the scapula.



Exposure of chest wall

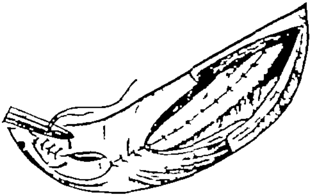
19 The chest wall is exposed by division of the latissimus dorsi, the serratus magnus and the pectoralis major muscles, usually in the plane of the fifth rib. This rib is identified by counting as described in postero-lateral thoracotomy. The periosteum and perichondrium are incised from the sternum in front, backwards beneath the scapula as far as the angle of the rib. The periosteum and perichondrium are raised.





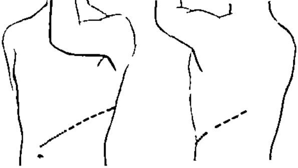
Entry into pleural cavity

20 Entry into the pleural cavity is through the rib bed. Division of the internal mammary vessels at the front end of the wound aids exposure, permitting wide separation of the wound by the rib spreader



Closure of the wound

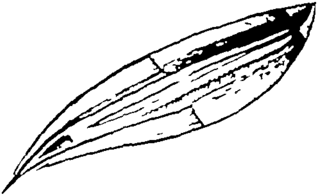
21 This follows the same pattern as in the postero-lateral approach. Where difficulty arises with approximation of the front end of the wound, suture of the perichondrium to the cartilage is often a satisfactory solution to the problem.



LOWER APPROACH (ABDOMINO-THORACIC)

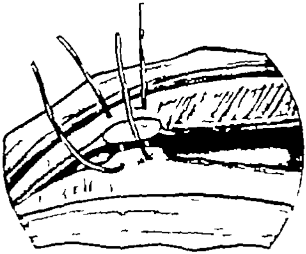
Skin incision

22 This begins in the mid-abdominal line, immediately above the umbilicus and crossing the costal margin opposite the eighth or ninth rib whichever is preferred, continuing parallel to it to approximately the post-axillary line.



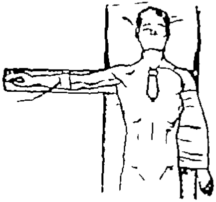
Exposure of chest wall

23 The great muscles of the chest and the abdominal wall are divided in the usual way exposing the ribs and the costal margin The periosteum and perichondrium are then raised, allowing access to both chest and abdomen through the rib bed and the divided costal margin.



Closure of the wound

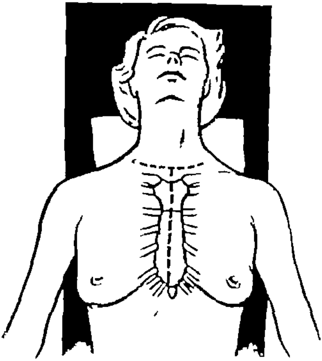
24 Apart from firm approximation of the costal margin with stout silk or wire sutures, this is in no way different from the standard method.



ANTERIOR THORACOTOMY

Position of patient on table

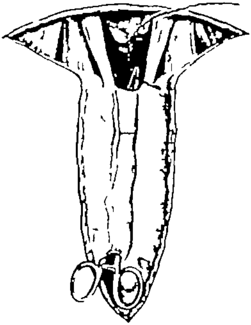
25 The full supine position with one arm abducted and the other slung alongside the table to give access to the lateral aspect of the chest wall should be used.



MEDIAN STERNOTOMY

The Incision

26 This is T-shaped, a lower collar incision being combined with a mid-line vertical incision prolonged on to the abdominal wall just to one side of the xiphoid process.
The skin is dissected back on each side to the lateral sternal border and the periosteum is raised for a short distance only on either side of the central incision



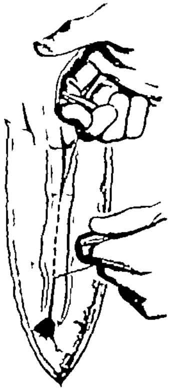
Exposure

Introduction of Gigli saw

27 Exposure of the mediastinum is obtained by dissection, using small gauze mops on the end of Robert's forceps, above and below the sternum in the immediate substernal tissue plane. When a clear space has been made a Gigli saw is drawn beneath the sternum.

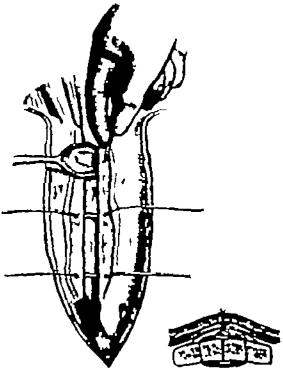
Division of sternum

28 The sternum is divided in line with the central incision the insertion of a mechanical retractor will then expose the anterior mediastinum.



Closure of the wound

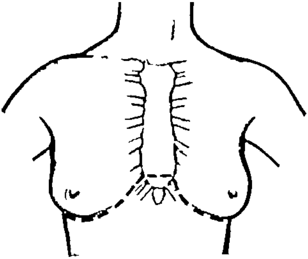
29 The sternum is approximated and held firmly together by several interrupted wire sutures, introduced with an awl and a protective spoon.



TRANSVERSE STERNOTOMY

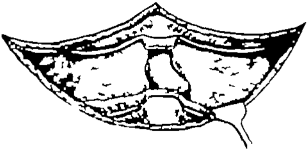
The incision

30 The incision combines bilateral submammary incisions with a transverse division of the sternum, usually between the fifth and sixth costal cartilages.



Exposure

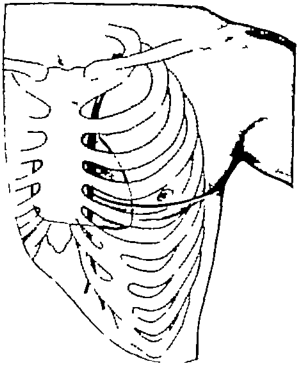
31 Exposure is obtained by the vertical retraction of the two halves of the wound, having first divided both internal mammary vessels.
The wound is closed by approximation and wire suture of the divided sternum, combined with "periosteal suture" on either side.



LEFT ANTERIOR THORACOTOMY

The incision

32 The incision extends from the left lateral border of the sternum to the mid-axillary line at the level of the fourth or fifth costal cartilage. Exposure is obtained by dividing the superficial muscles, access to the left pleural cavity being through the fourth or fifth intercostal space. If exposure after manual retraction is inadequate quick division of the costal cartilages above and below with the scalpel is all that is required to obtain a wide opening in the pericardium for cardiac massage, cardiac injections and, if necessary, defibrillation of the ventricles.



SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

GENERAL

Rib fractures

Fractures of the rib may arise as the result of forcible mechanical retraction of the wound—often avoidable by using a longer incision Nevertheless, should this fracture occur it is no great handicap to the patient providing that sharp edges of the ribs are trimmed so that they do not produce wounds in the lung

Injury to an intercostal vessel

This may cause haemorrhage obviously it is an avoidable complication.

Injury to the intercostal nerve

This may lead to severe post-operative intercostal pain and often a persistent late neuralgia, and is a hazard of any interference with the intercostal nerve it is preventable by using the supracostal technique when entering the chest.

Dehiscence of the wound

Wound dehiscence is extremely rare although small intercostal openings allowing the leakage of fluid and air into the wound are not unusual

Surgical emphysema

This is common but rarely of importance unless the pleural cavity is inadequately drained in the presence of a persistent air leakage from the lung or a bronchus.

Traction and compression nerve injuries to the brachial plexus

Such injuries are very uncommon but may arise as a result of bad positioning or rough handling of the thoracic patient on the table.

Children in particular are prone to this complication.

LATERAL THORACOTOMY

Immediate post-operative care

Bronchoscopy with careful toilet of the bronchial tree should be undertaken before the patient leaves the theatre

When the patient is transported from the theatre to the ward, care must be taken to see that the intercostal tube is clipped off, before temporarily disconnecting it from the underwater seal drainage bottle

Physiotherapy

Morphine in small regular doses for the first 48 hours facilitates ventilation and aids coughing and co-operation with the physiotherapist. It must be used with care in the elderly and the very young

Circulation and drainage

All details of the circulation need watching while x ray control of the lung fields is essential

The drainage tube is removed after 48 hours unless contra-indicated by persistent leakage of air blood or chyle

ANTERIOR THORACOTOMY

MEDIAN STERNOTOMY

Drainage

Drainage may be needed to prevent haematoma formation and is best carried out by a tube placed either above or below the sternum.

In addition, the pleural cavity may require drainage in the usual manner

Complications

A complication sometimes encountered is separation of the sternum with non-union this, however is rarely seen if multiple stout wire sutures are used.

TRANSVERSE STERNOTOMY

Drainage

Drainage of both pleural cavities may be necessary using the usual thoracotomy method.

[The illustrations for this Chapter on Surgical Access to the Chest were drawn by Miss P Carter]

INTERCOSTAL DRAINAGE OF EMPYEMA

VERNON C. THOMPSON F R.C S

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[This Chapter should be studied in connexion with the succeeding Chapter on Rib Resection for Empyema as the text and illustrations overlap to some extent]

PRE-OPERATIVE

Indications

As a result of modern chemotherapy empyema thoracis is becoming an uncommon complication of pulmonary disease When it does occur the correct treatment is by aspiration and the instillation of suitable antibiotics until the pleural space is sterile and obliterated. When these methods fail resection is often the treatment of choice. The indications for drainage of an empyema have therefore greatly diminished in recent years. Intercostal drainage is now employed only in emergency and can be carried out in the patient's bed. The emergency arises (1) in a positive pressure pyo-pneumothorax (2) when an empyema ruptures into the lung and threatens to drown the patient (3) when a lung abscess ruptures into the pleural cavity and (4) when a virulent infection cannot be controlled by aspiration and chemotherapy

Intercostal drainage has the advantage over rib resection that the entry wound in the chest wall may remain air-tight for some days and suction may be applied without air leaking round the tube. It also has the advantage in certain cases that the tube may be introduced without allowing air to enter the chest.

In a total empyema it is most undesirable that air should be allowed to enter the pleural cavity before the size of the space has been very considerably reduced.

The disadvantages of intercostal drainage are that the tube may cause pain and the size of the tube is usually inadequate so that it is liable to become obstructed by fibrinous clots.

Site of drainage

An empyema should be drained one rib space above its most dependent part. In a simple empyema this is often in the interspace below the angle of the ninth rib in the paravertebral gutter In localized empyemas the site for drainage must be ascertained by preliminary studies of postero-anterior and lateral radiographs (see Rib Resection)

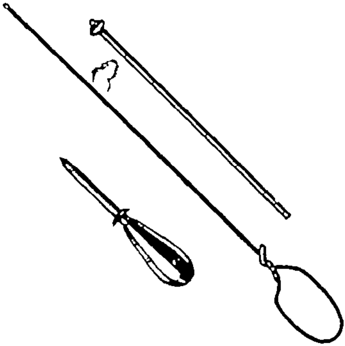
Position of the patient

The patient should be in a comfortable position in bed. If there is a broncho-pulmonary fistula and the patient is coughing up the contents of the empyema, he should be sitting up and leaning forward over a bed-table for support. If there is no fistula he may lie on the sound side supported by pillows.

Anaesthesia

Having selected the site the chest wall is infiltrated with local anaesthetic (procaine, 2 per cent) down to the pleura. An area of skin and subcutaneous tissue about 1 inch in diameter is first infiltrated. The needle is then advanced slowly through the chest wall injecting the solution continuously until the pleura is reached—the needle is then slowly withdrawn, again injecting the solution continuously until the skin is reached. About 20 ml. of local anaesthetic are required. It is important to get a good concentration into the extrapleural layer in the intercostal space.

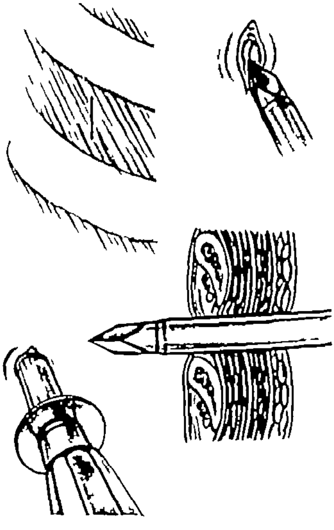
Pus is then aspirated through a large bore needle to confirm that the site is well chosen. If no pus is obtained the site has not been well chosen and another must be selected.



THE OPERATION

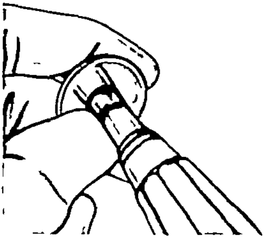
The instruments

1 The special instruments required are a trocar and cannula, a Malecot or De Pezzer catheter and an introducer The largest trocar and cannula should be selected that will pass through the intercostal space, and the catheter should be of a size that will pass through the cannula only when it is on stretch.



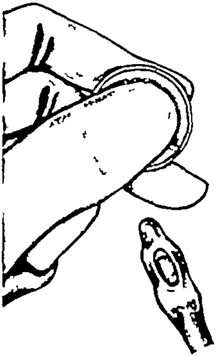
Introduction of the trocar and cannula

2 Having selected the site of drainage and having infiltrated it with the local anaesthetic and confirmed that the site is correct by aspiration, a small incision is made in the skin the size of the diameter of the trocar The trocar and cannula are then plunged through the incision into the pleural cavity



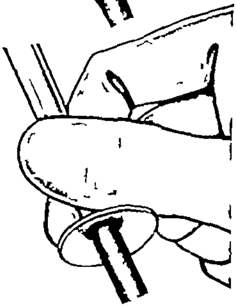
Withdrawal of the trocar

3 If there is no gas in the pleural cavity it is important to prevent the entry of air from the atmosphere The cannula is therefore gripped between the index and middle fingers of the left hand and the thumb is ready to close the aperture in the cannula as the trocar is withdrawn



Introduction of the catheter

4 The catheter is held stretched over the introducer in the right hand while the thumb of the left hand seals the cannula. The catheter is introduced simultaneously as the thumb is removed from the aperture of the cannula.

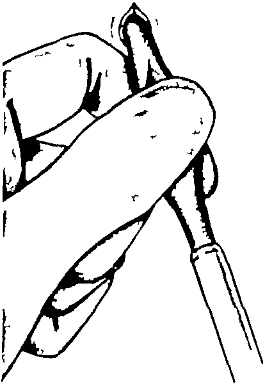


Withdrawal of the cannula

5 Keeping the catheter stretched on the introducer the cannula is withdrawn from the chest over the catheter

Withdrawal of the introducer

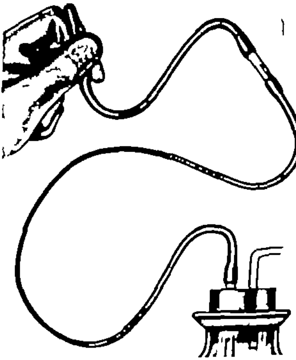
6 As the cannula becomes free from the chest wall the catheter is gripped and closed by the thumb and index finger between the tip of the cannula and the chest wall. The introducer is then withdrawn It is felt between the thumb and index finger as it escapes, the catheter being kept airtight round the introducer during the procedure. This is followed by the complete removal of the cannula from the catheter



Connexion to the under-water seal bottle

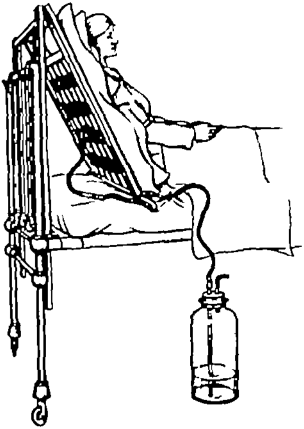
7 While the catheter is still gripped to prevent the access of air to the pleural cavity the catheter is connected by means of a glass connexion to an under-water-seal empyema bottle. The connexion to the bottle should be carried out by an assistant. If it is done by the surgeon himself he should clamp the tube before releasing his finger pressure on it.

All these precautions to prevent the entry of air to the pleural cavity are unnecessary if there is a pleuro-pulmonary fistula.



8 **Position of the patient**

The patient should be nursed in the sitting-up position on a bed rest with slats. If the tube has been inserted in the paravertebral gutter the tube should be led through the slats to a water-seal bottle The essentials are that the tube should be draining into a bottle through a tube which drains under a water level. Another tube from the bottle should be above the water level and suction can be applied to this exit tube if required. There should be no kinks or loops in the tube which should be allowed a free dependent drop to the bottle.



POST-OPERATIVE CARE

If there is no broncho-pleural fistula it is desirable to prevent the entry of air into the pleural cavity as long as possible.

The drainage bottle should be changed daily When this is done the tube from the chest should be closed with two clamps between the chest and the glass connexion while the bottle is being changed. In order to maintain a high negative pressure in the pleural cavity the exit tube from the bottle (the cork of which should be close fitting and airtight) should be connected to a suction pump run at a negative pressure of about 80 cm. of water After about 1 week air is likely to leak into the pleural space round the tube so that closed drainage can no longer be maintained.

If the tube becomes blocked, the simplest procedure is to remove it and insert another one instantaneously rather than to try and remove the obstruction in the tube. It is dangerous to attempt to clear the tube by irrigation as this may cause an air embolism, which could be fatal.

There comes a time in the use of intercostal drainage when either because the tube is causing pain or because the drainage is inadequate serious consideration must be given to employing a larger tube by rib resection.

Breathing exercises of the controlled inspiratory type should be instituted from the day after operation.

The tube should not be removed finally until the pleural space has become completely obliterated. This can only be ascertained by radiography after the injection of a contrast medium into the tube track.

For further particulars about the management of the tube the reader is referred to Rib Resection for Empyema (Part V page 50)

The patient should be treated by suitable antibiotics given systemically after the nature of the organism and its sensitivity to the antibiotics are known. Normally this will have been discovered before drainage is instituted. The patient may also require treatment for anaemia by iron therapy and possibly by blood transfusion The general nutrition should be maintained by a high protein diet as the loss of protein in the pleural discharge may be quite considerable

[The illustrations for this Chapter on Intercostal Drainage of Empyema were drawn by Miss Patricia Archer]

RIB RESECTION FOR EMPYEMA

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[This Chapter should be studied in connexion with the preceding Chapter on Intercostal Drainage of Empyema as the text and illustrations overlap to some extent.]

PRE-OPERATIVE

Indications and contra-indications

Rib resection for empyema should only be employed when more conservative methods have failed. It should never be employed as the primary treatment. Rib resection is essentially an open method of drainage and the size of the empyema cavity must be reduced to the smallest possible dimensions by aspiration and possibly intercostal drainage beforehand.

The primary treatment of empyema is by aspiration and chemotherapy. A sterile empyema of a persistent nature is best treated by resection. A pure tuberculous empyema should never be treated by open drainage.

It is only when conservative measures fail or are doomed to fail that rib resection should be employed. The causes of failure of conservative measures are (1) infection with an organism resistant to all antibiotics, (2) loculation of the empyema by massive deposits of fibrin or blood clot, (3) persistent re-infection by a broncho-pleural fistula or by an oesophageal fistula, and (4) post-operative infections of the pleural cavity by bronchial fistula after lung resection or by oesophageal fistula after oesophago-gastric resections.

Anaesthesia

If there is no bronchial fistula the patient may be given a general anaesthetic, but if a fistula is present local anaesthesia should be employed. The technique is a little more elaborate than that for intercostal drainage. The line of incision should be infiltrated together with the subcutaneous and deep fascial planes. The intercostal spaces above and below the rib to be resected can be infiltrated after they have been exposed.

Site of drainage

It is essential that drainage should be at the lowest point, but this requires some qualification. The lowest point should be in relation to the patient's normal position in bed, which is semi-recumbent. The site for gravitational drainage should therefore almost invariably be posterior. Another consideration which must be borne in mind is that the diaphragm always rises in the obliteration of an empyema space. Allowance must be made for this, and the tube should be introduced one rib space above the diaphragm, otherwise the rising of the diaphragm may seal off the end of the tube.

The site of drainage must be determined after a study of postero-anterior and lateral x-rays and a careful rib count. The lowest point of the empyema can be most clearly demarcated by preliminary injection of Lipiodol into the empyema space.

Finally, the site is confirmed by aspiration above and below the rib selected for resection, after exposure by a vertical incision.

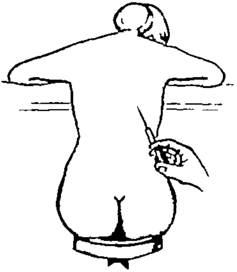
THE OPERATION

Position of the patient

1 If there is no broncho-pleural fistula and if the patient is able to lie on the contra lateral side without distress the operation can be carried out in the lateral position under a general anaesthetic.

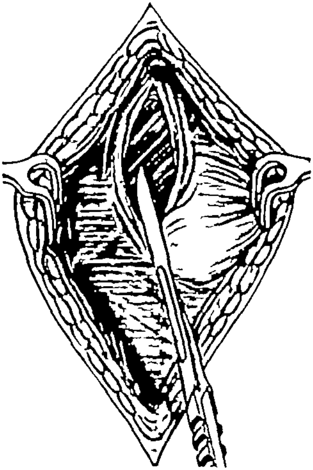
In broncho-pleural fistula

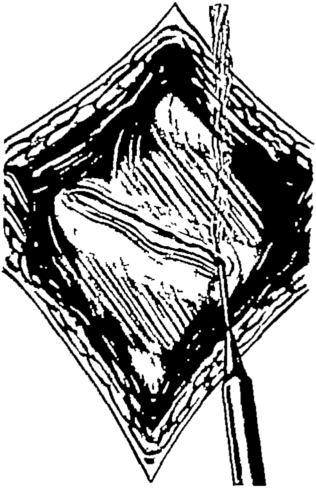
2 If there is a broncho-pleural fistula and the patient is unable to lie on the contra-lateral side, the operation should be carried out under local anaesthesia with the patient sitting on a stool leaning forward with the arms supported over the operating table.



The incision

3 The incision should be a vertical one 8 inches long. This allows extension upwards or downwards if it is not quite correct as shown by aspiration above and below the rib previously selected for resection. The incision is carried through skin, subcutaneous tissues, deep fascia and muscle to the ribs and intercostal muscles.

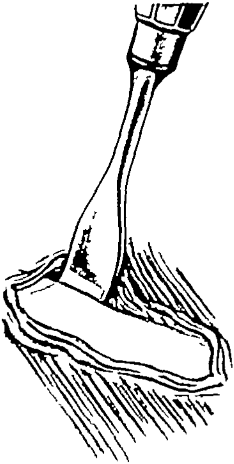




Incision in periosteum

4 When the rib has been exposed and selected for resection, the edges of the wound are retracted along the line of the rib and the periosteum is incised for 2–3 inches with the diathermy knife

Before resecting the rib aspiration should be performed above and below the rib to confirm that the site is well chosen



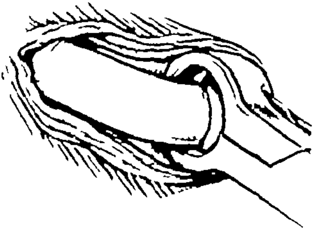
Elevation of the periosteum

5 With a rugine the periosteum is separated from the rib On the upper surface of the rib the rugine should be carried forwards in the direction of the intercostal muscle fibres and on the lower surface it should be carried backwards. In this way the part of the rib to be resected should be completely freed from its periosteum.

Care should be taken to keep close to the rib and not to tear the periosteum which should be left intact. If this procedure is not carried out carefully there is a risk of tearing the intercostal vessels with troublesome haemorrhage which will require ligation of the vessels after the segment of rib is removed. It is not possible to control the haemorrhage until the rib resection has been completed.

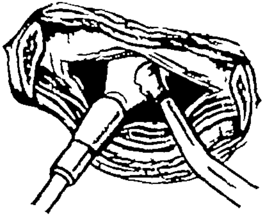
Resection of a segment of the rib

6 With a costotome of which there are many varieties, and almost any can be employed providing it cuts the rib cleanly a portion of the rib 2–3 inches long should be resected.



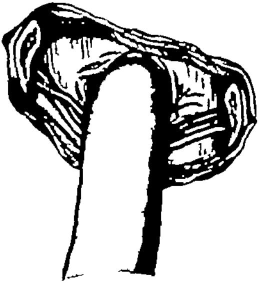
Opening of the pleura and cleaning of the empyema space

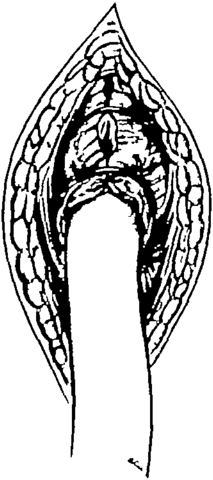
7 The periosteum and pleura deep to the rib should be incised keeping well above the leash of intercostal vessels and nerve. The contents of the empyema are removed with a sucker The empyema cavity is inspected with a Nelson light and great care should be taken to remove all fibrinous deposits from the surface of the pleura with the sucker leaving the space quite clean.



Inserting rubber tube into pleural cavity

8 A wide bore rubber tube is then inserted into the pleural cavity its external diameter should be about 2 cm. and it should project into the cavity about the same distance The pleura and deep periosteal layer should then be sutured round the tube as closely as possible.

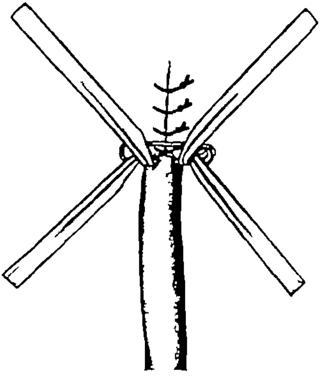




Suture of the wound

9 The muscles, deep fascia, subcutaneous tissue and skin are then loosely sutured round the tube, using catgut for the muscles and unabsorbable sutures for the skin

No attempt should be made to suture the tissues tightly as some drainage to the wound itself must be allowed. Tight suture will cause oedema of the wound and possibly cellulitis this may tend to withdraw the tube from the empyema space.



Fixation of the tube

10 The tube should be anchored by the insertion of a safety pin through the upper wall of the tube (not through the middle of the lumen as this may cause obstruction by clots) and the safety pin should be fixed to the skin by adhesive strapping taken round one arm of the safety pin on each side of the tube as illustrated. The length of each piece of strapping should be 9 inches, the width ½ inch, and the angles between the arms of the strapping should be 90 degrees.

The tube should be connected to an under-water-seal bottle and the patient should be nursed as for Intercostal Drainage of Empyema.

POST-OPERATIVE CARE

Breathing exercises of the inspiratory type should be instituted from the day after operation Suction at about 80 cm. of water should be applied to the exit tube from the bottle The patient should be allowed out of bed and encouraged to take exercise as soon as possible on such occasions the tube can be disconnected from the suction apparatus, but this should be applied whenever the patient is in bed.

X-ray examination should be made weekly at first to show the diminution in the size of the pleural space. When this is no longer visible on direct radiography the space can be outlined by filling it with a radio-opaque material such as Lipiodol

The technique is to remove the tube, to lie the patient so that the wound in the chest wall is uppermost and to fill the space with Lipiodol with a syringe and catheter until it overflows. The sinus is then packed with gauze, all Lipiodol on the skin is cleaned off a metal marker is placed on the sinus at skin level which is then sealed off with adhesive strapping and radiographs are taken in the erect lateral and postero-anterior positions.

The tube should not be finally removed until the pleural space has become completely obliterated and only the tube track in the chest wall remains.

Causes of chronic empyema

The commonest causes of chronic empyema are mismanagement of acute empyema. These can be given as follows

Drainage has been too soon or too late. Drainage has been in the wrong place. The tube has been removed too soon. Foreign bodies (for example tubes) have been lost in the pleural cavity A bottle-neck has sealed off the tube.

Other causes of chronic empyema are Serious underlying disease in the lung such as tuberculosis or carcinoma Specific infections of the pleura such as tuberculosis or actinomycosis. Persistent broncho-pleural fistula. Osteomyelitis of rib or spine.

The fundamental points in the management of the tube are that the end of the tube should be at the bottom of a cavity but when a long track exists the end of the tube should be about 1 inch from the end of the track. If the end of the tube is kept at the bottom of a long track it is highly probable that a bottle-neck will seal off the top of the track.

Once an empyema has reduced itself to a long track, it may be necessary to lengthen the tube. A good rule is to remove the tube once a week, to measure the length of the track with a gum elastic bougie and to adjust the tube so that it is 1 inch shorter than the track. When the track is only 2 inches long the tube may be removed.

[The illustrations for this Chapter on Rib Resection for Empyema were drawn by Miss Patricia Archer]

TUMOUR OF CHEST WALL

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PRE-OPERATIVE

Indications for surgery

Most primary tumours of the chest wall arise from the ribs or sternum. A high proportion are potentially or actually malignant. Because of this and the difficulty of diagnosis all should be excised. The chest wall is sometimes directly invaded by carcinoma of the lung and may be successfully removed with the underlying lung A small number of cases of breast cancer involving the parietes or of local recurrence after radical mastectomy are amenable to surgery

Wide excision should be practised whenever the tumour is known or suspected to be malignant. When one or two ribs are involved it is usually possible to use neighbouring tissues to close the defect When a large area of the bony framework is removed a prosthesis should be used to close the gap This inhibits paradoxical movement of the underlying lung which is particularly dangerous in the immediate post-operative period. It prevents lung hernia, protects the thoracic viscera from possible future trauma and gives the patient a needed sense of security The best prosthesis yet devised is of stainless steel mesh (Ethicon 60 mesh wire, 0·008 woven) This is used in single thickness or doubled for very large defects. The use of a mesh allows fibrous tissue to grow into its interstices and so fix it in the chest wall It is cheaper than tantalum and fragments less readily with the passage of time.

A plastic mesh, inert as steel but even more rigid, easier to work and cheaper to produce may be the ideal prosthesis for the future.

Special contra-indications

Widespread metastases and involvement of the vertebrae or of the lowest trunk of the brachial plexus at the apex of the hemithorax by direct spread, contra-indicate operation.

Involvement of intra-thoracic structures such as lung, pericardium or diaphragm does not exclude surgery provided that it is possible to remove the affected area.

Pre-operative preparation

Careful radiographic studies must be made to assess as far as possible the extent of the disease.

Breathing exercises and the exhibition of appropriate anti-bacterial drugs to combat pulmonary infection are begun at least 1 week before operation.

Where skin is involved the patient should be warned that skin grafting may be required.

Anaesthesia

General anaesthesia, using an endotracheal tube and controlled respiration, is essential

Position of the patient

This depends upon the site of the tumour When the anterior part of the chest wall is involved the patient lies supine with the upper limb extended so that the pectoral and latissimus dorsi muscles are stretched and displaced as far as possible from the field of operation. When the lesion is in the axilla a similar position is used with the table tilted laterally so that the affected area is uppermost.

For a subscapular tumour the lateral position is adopted as for thoracoplasty a similar incision being made in order to mobilize the scapula away from the chest wall.

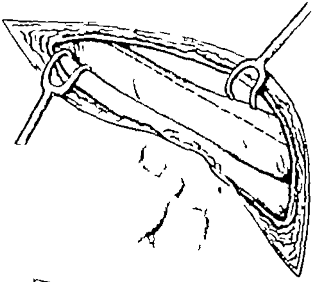
THE OPERATION

The incision

1 This follows the line of the ribs where possible unless the skin is involved when the first incision curves above and well away from this area.

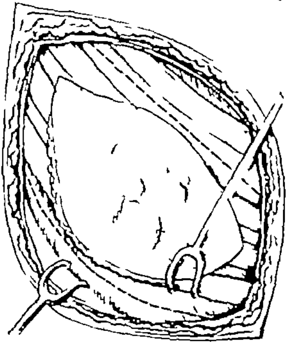
Exploratory thoracotomy

2 Underlying muscles are divided to expose the intercostal space above the first normal rib from the diseased area. Retraction is exerted on the ribs above and below by double hook retractors and an incision made through intercostal muscles and parietal pleura big enough to allow inspection of the pleural aspect of the tumour and assessment of its extent. Gross involvement of internal structures or scattered malignant nodules precludes further surgery



Additional exposure

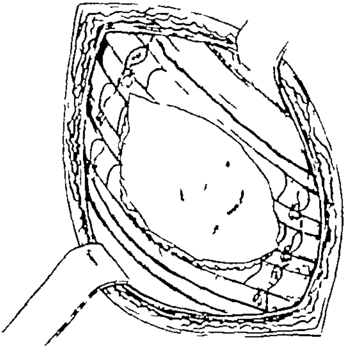
3 A further skin incision is made well below the tumour joining the first at its ends to form an ellipse An intercostal incision is made below similar to the first described and extended as far as the proposed line of rib section This should be at the very least 2 inches from the tumour edge.

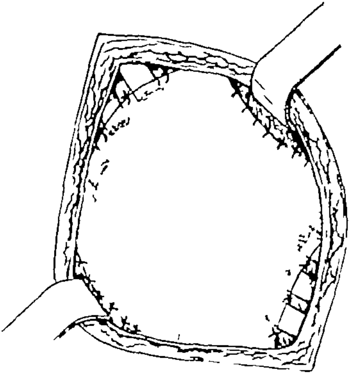


Excision of chest wall

4 The ribs are freed from periosteum sufficiently to allow the insertion of a Tudor Edwards costotome and are divided in turn anterior and posterior to the area to be removed. Pressure from within the chest on the flap thus formed displaces the rib segments outwards allowing the soft tissues to be divided by vertical anterior and posterior incisions. Intercostal muscles, periosteum, rib bed and the intercostal neurovascular bundle are incised in turn, together with the parietal pleura until the excision is complete.

Each neurovascular bundle is divided between ligatures in two places, care being taken that the ligated ends left behind are allowed to retract under cover of the remaining rib and intercostal muscles. At this point any structure within the chest, such as lung which is also involved by the tumour is now more readily removed.



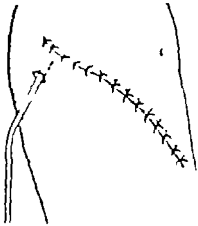


Insertion of prosthesis

5 A sheet of stainless steel mesh is now cut to size and doubled if required and its edges turned in to avoid subsequent protrusion through the skin. The edge overlaps the defect by $\frac{1}{2}$ inch and is tacked to surrounding muscle and periosteum by interrupted sutures of silk or fine stainless steel. The lung or pericardium suffers no harm from being in contact with the prosthesis.

Closure of wound and drainage

6 An intercostal drainage tube is inserted through a separate incision posteriorly at the most dependent part of the chest cavity anchored to the skin and attached to an under-water drainage bottle. This may be done before or after the prosthesis is fixed in position. Where it is possible to reconstruct muscles which have been divided or partially excised, this should be done It is essential to cover the prosthesis with skin and sub-cutaneous tissue. If much skin has been removed and there is tension at the suture line releasing incisions should be made well away from it and if necessary skin grafted to the raw areas. When the wound has been covered with sterile gauze, strips of 8 inch zinc oxide strapping are applied over the affected area from the spines of the vertebrae to the sternum during expiration. This gives more support than an elastic dressing and reinforces the effect of the prosthesis in minimizing paradoxical movement.



SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

On recovery from anaesthesia coughing should be vigorously encouraged. Oxygen may be required by patients with poor respiratory reserve.

Pulmonary collapse

If this occurs despite physiotherapy bronchoscopy should be carried out.

Pain

Pain is variable in intensity Physeptone, 10 mg or pethidine, 100 mg., in repeated doses is usually adequate. Morphine may be given but as this inhibits the cough reflex it should be prescribed cautiously and only if the patient co-operates by coughing when required.

Some degree of pain or discomfort may be felt for many weeks after operation but this gradually diminishes, although numbness in the region served by the divided intercostal nerves will persist indefinitely

Haemorrhage

Blood-stained fluid will drain from the chest for a few days. If large in amount gentle continuous suction should be applied by means of a Robert s pump The tube should be removed after 3 days.

Effusion beneath the skin flaps should be removed by aspiration

Abdominal weakness

If the lower intercostal nerves are divided weakness of the abdominal wall on that side is to be expected and may require a supporting abdominal belt.

[*The illustrations for this Chapter on Tumour of Chest Wall were drawn by Miss Jill Hassell*]

THORACOPLASTY WITH APICOLYSIS

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PRE-OPERATIVE

Aim of operation

The operation is designed to produce concentric relaxation of the upper lobe by apical mobilization; the relaxation is maintained by subperiosteal resection of the ribs overlying the mobilized area.

Lateral thoracoplasty is used occasionally in place of thoracoplasty with apical mobilization for apical disease. It was used extensively in the treatment of tuberculous empyema but has now largely been superseded by pleurectomy and decortication. It consists of excision of the ribs as described above without apicolysis.

Anterior thoracoplasty is now rarely performed. It consists of removing the anterior segments of the upper ribs through an anterior or axillary incision. It was employed as an adjunct to the posterior thoracoplasty to achieve greater mobilization than could be obtained with the posterior type alone.

Indications

Thoracoplasty is particularly indicated for chronic fibro-caseous or cavernous lesions in the upper lobe which cannot be controlled by simpler measures (for example, chemotherapy or rest) and which are not considered suitable for resection.

Contra-indications

Children, and adults over the age of 60, are generally regarded as unsuitable for thoracoplasty. Operation should be delayed in the presence of active, progressive disease or when toxicity is marked.

Patients whose general condition is poor or whose respiratory reserve is low should not be submitted for operation.

Associated conditions (asthma, chronic bronchitis, emphysema and ischaemic heart disease), if severe, add to the hazards of the operation.

Pre-operative preparation

Every patient should have an adequate period of anti-tuberculous chemotherapy before operation.

Diaphragmatic breathing exercises, coughing exercises and arm and shoulder movements should all be given beforehand.

Patients with excessive amounts of sputum should be treated with the appropriate antibiotics.

Anaesthesia

Either general or local anaesthesia can be employed.

(1) General anaesthesia is effected by thiopentone, a relaxant, nitrous oxide and oxygen using an intratracheal cuffed tube.

(2) Adequate premedication is essential with local anaesthesia. Omnopon $\frac{1}{3}$ gr and scopolamine $\frac{1}{150}$ gr together with a barbiturate are usually effective. Supplementary intravenous doses of Omnopon can be given during the operation if required.

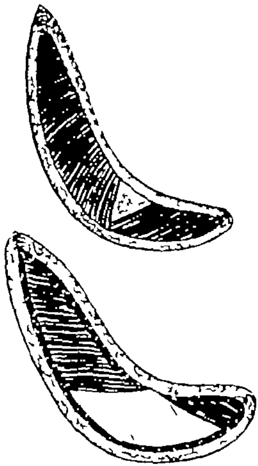
The skin and muscles in the line of the incision are infiltrated extensively with 0·2 per cent lignocaine (Xylocaine) with 0·5 ml 1:1,000 adrenaline using a total volume of about 400 ml.

A paravertebral block of the upper 7 thoracic nerves is carried out using 0·4 per cent lignocaine and a lower brachial plexus block is sometimes performed in addition.

THE OPERATION

Incision

1 The skin incision is "J" shaped, curving 2 fingers breadth below the angle of the scapula with the arm hanging well forward. The vertical limb is placed 2–3 cm. from the vertebral spines. It extends from the level of the first thoracic spine to the posterior axillary line.



Division of muscles

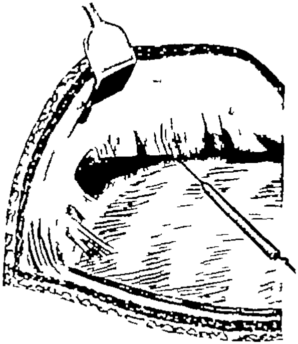
2 The superficial (trapezius and latissimus dorsi) and deeper (rhomboids and serratus anterior) layers of muscle are divided in the line of the incision.

Exposure of ribs

3 The scapula is elevated vertically to expose the layer of areolar tissue between it and the chest wall. This layer is incised and the scapula displaced forwards and elevated further to expose the posterior aspect of upper digitations of the serratus anterior muscle. The narrow gap between the scalenus medius and the uppermost digitation of the serratus is opened and developed by blunt dissection in the areolar plane on the anterior surface of the serratus (that is, in the axilla) In this way the digitations of the serratus arising from the upper ribs are isolated and can now be cut with scalpel or diathermy close to their origin from the ribs and intercostal spaces to the level of the fourth rib

The serratus posterior superior is excised and the upper ribs are now completely exposed.

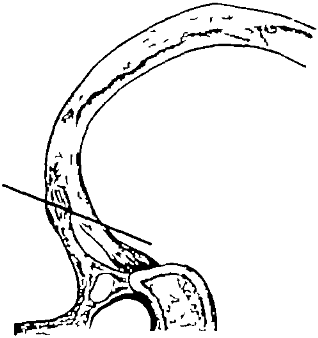
The insertions of the scalenus medius and posterior are then detached from the first and second ribs.



Removal of second and third ribs

4 The periosteum of the third rib is incised with diathermy from its costo-transverse joint to the anterior axillary line and is then stripped from the rib The erector spinae muscle is then retracted to expose the costo-transverse ligament this is divided with right-angle bone shears and the blades of the latter are then advanced obliquely downwards and inwards to divide the neck of the rib obliquely The rib is then divided transversely at its anterior end.

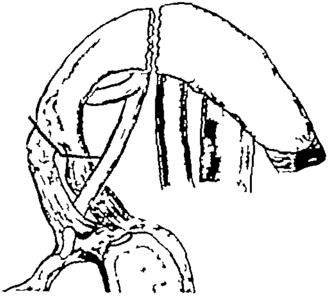
The second rib is treated similarly



Removal of first rib

Posterior portion

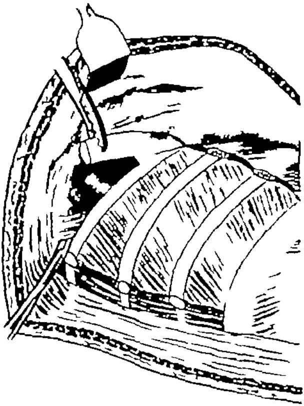
5 The first rib is denuded of periosteum throughout its entire length Care is taken not to injure the axillary vessels and brachial plexus which lie closely applied to its inner border The rib is then divided near its centre and removed in 2 portions The posterior portion is mobilized by dividing the costo-transverse ligament and with the fragment pulled forwards it is removed by dividing through the neck.

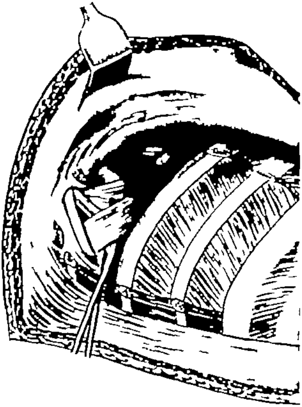


Anterior portion

6 The anterior fragment is firmly grasped in bone-holding forceps and pulled downwards to expose the costo-clavicular ligament. This is divided with scissors or rugine and the rib removed by cutting through the costo-chondral junction.

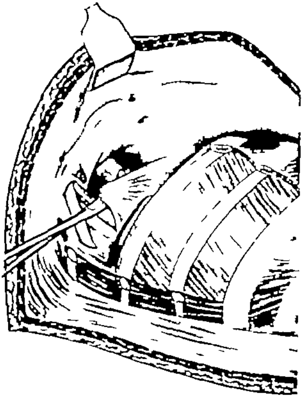
The first intercostal muscle is then excised in order to give an unhampered view of the apex.





Apical mobilization, division of Sibson's fascia

7 Apical mobilization is best achieved by deliberately and cleanly exposing the first dorsal nerve, the subclavian artery and the innominate vein. The exposure of these structures involves division of Sibson's fascia and its 3 thickenings (the bands of Sibelau). The first band lies superficial to the nerve, the second between the artery and the nerve and the third in front of the artery. These bands are isolated and divided and the intervening, less dense, fibrous fascia also divided.

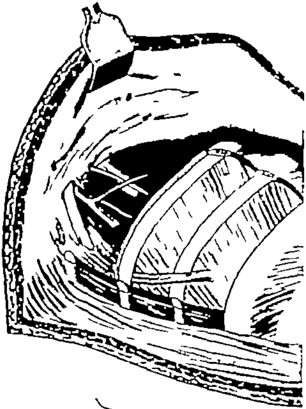


Exposure of the innominate vein

8 Some fibres of the scalenus anterior which insert into the pleura (scalenus pleuralis) require division in order to expose the innominate vein with the internal mammary artery running across it.

Further mobilization

9 The mobilization is carried downwards separating the lung from the mediastinal structures by a process of sharp and blunt dissection until the azygos vein is reached on the right side and the aortic arch exposed on the left side.

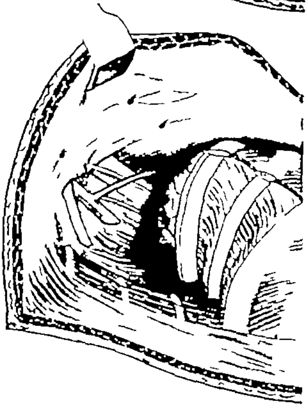


Division of the intercostal bundles

10 The upper 8 intercostal bundles and muscles will require division between ligatures during the later stages of the mobilization

Streptomycin powder is sprinkled over the mobilized apex.

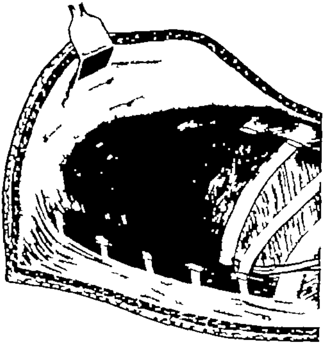
The wound is closed carefully in layers without drainage of the space.



SECOND STAGE

11 This is performed 2 weeks after the first stage. The original wound is re-opened and the scapula mobilized. Blood and clot are removed from the extra fascial space.

Two or more ribs are resected sub-periosteally and removed as already described. The bundles and muscles are divided posteriorly and further apical and posterior mobilization of the lung is carried out especially in the para-vertebral gutter Third and subsequent stages are performed at intervals of 2 weeks until the necessary number of ribs has been removed to relax the diseased area It is unusual to require more than 2 stages.



Bibliography

Bjork, V O (1954) *J thorac. Surg.*, **28**, 194.
Brock, R. C. (1955). *Thorax* **10** 1
Price Thomas, C., and Cleland, W P (1942) *Brit. J Tuberc.*, **36**, 109
Sellors, T H., Jackson, J W., and Callanan, J G (1955). *Thorax*, **10** 191
Semb C. (1935). *Acta chir scand.*, Suppl. 37

MODIFICATIONS OF THORACOPLASTY

Several modifications of the "Semb thoracoplasty with apicolysis have been described but all have certain basic points in common and little purpose would be served by describing them individually

In essence they all aim at (1) One stage operation with mobilization of the apex. (2) Maintenance of the stability of the chest wall and avoidance of paradoxical movement by developing an osteo-plastic flap with the divided upper ribs and suturing it in place over the relaxed lung

Indications

These operations are most applicable to patients with limited fibro-caseous or cavernous disease in the upper lobe or in patients with a limited respiratory reserve

Contra-indications

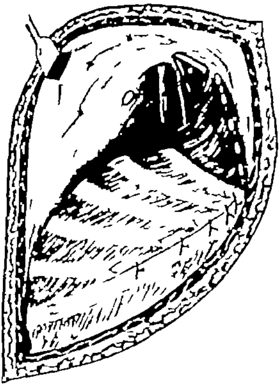
Contra-indications are as for thoracoplasty with the addition of significant disease extending below the level of the fifth and sixth ribs posteriorly

THE OPERATION

12 The illustration is of the completed Bjork type of thoracoplasty on the right side. The exposure is as for the standard thoracoplasty

The requisite number of ribs are exposed and divided through the neck The first rib can either be removed or the periosteum stripped from its lower surface Varying segments of the divided ribs are then resected so that each rib in turn can be sutured with wire to the uppermost intact rib The periosteum of the first rib is sutured to the mediastinum in order to prevent apical expansion alongside the mediastinum

The ribs are drilled and fixed firmly in place with stainless steel wire



POST-OPERATIVE CARE

The most important aspects are the maintenance of adequate ventilation and the control of bronchial secretions. Patients are best nursed sitting up Any paradoxical movements of the chest wall (following removal of ribs) must be controlled with strapping Oxygen is given if necessary

The patient is given every encouragement to cough up secretions. A great deal can be done by nursing staff and physiotherapists in aiding coughing Expectorants are of little value, but inhalations may help to loosen secretions and relieve spasm.

Complications

Atelectasis is probably the commonest complication requiring attention. It is caused by the accumulation of secretions in the bronchial tree. It requires urgent treatment if secondary infection in the atelectatic lung is to be avoided. Measures designed to encourage expectoration should be intensified, but if not successful the bronchi must be aspirated at bronchoscopy

Spread of disease either in the same or opposite lung is connected with the aspiration of infected sputum into normal lung paradoxical movement of the chest wall and atelectasis

Once established, the only effective treatment lies in chemotherapy It is important to concentrate on preventive measures such as reduction of sputum before operation, control of bronchial secretions during operation, control of paradoxical breathing and the prevention of atelectasis.

Chylous effusion into the apical space may occur following accidental damage to the thoracic duct. The leak will often cease after several aspirations, but if it persists the fistula will have to be repaired at the second stage of the operation.

Infection of the apical space —Tuberculous or pyogenic infection of the apical space is not common The infection should be treated by regular aspirations or drainage.

[*The illustrations for this Chapter on Thoracoplasty with Apicolysis were drawn by Mr F Price*]

DECORTICATION
PLEURECTOMY EXCISION OF EMPYEMA

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PRE-OPERATIVE

Aim of operation

The object of the operation is the removal of the fibrous wall of the empyema cavity both from the lung surface and from the chest wall and diaphragm leaving the lung free and unhampered to fill the space formerly occupied by the empyema.

Decortication can be combined with resection of lung (pleuro-lobectomy pleuro-pneumonectomy) if the latter is diseased.

Indications

The operation is used in the treatment of sub-acute or chronic empyemas where simpler measures (repeated aspirations, drainage) have failed to eliminate the empyema cavity

Contra-indications

The operation is a severe one and patients who are frail or elderly or whose general condition is poor should not be submitted to it.

The operation should not be performed in a post-pneumonic empyema until the signs of pneumonia have disappeared.

Pre-operative investigations

An empyema is never a primary condition and every attempt should be made to determine its cause before embarking on surgical treatment. In addition, a precise knowledge of the state and condition of the underlying lung is essential before pleurectomy is undertaken.

Investigations which will be required are (1) cytological and bacteriological examination of the pleural fluid and sputum (2) bronchoscopy and (3) bronchography

Pre-operative preparations

(1) The empyema should be aspirated repeatedly before operation and sterilized by intrapleural antibiotics.
(2) Full ambulation and vigorous breathing exercises are essential for as long as practicable before operation.
(3) Systemic chemotherapy is advisable for 2–3 days before operation or longer if much sputum is present.

Anaesthesia

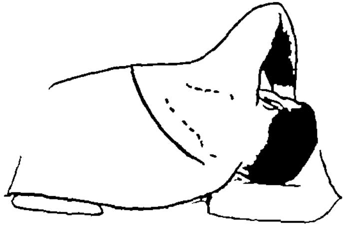
General anaesthesia with intratracheal intubation is employed. (Intrabronchial occlusion or one lung anaesthesia is not usually necessary)

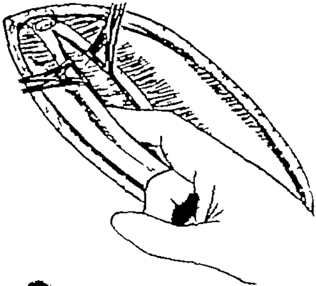
Hypotensive agents (Arfonad) may be useful in reducing the oozing from the chest wall and lung during mobilization

THE OPERATION

The incision

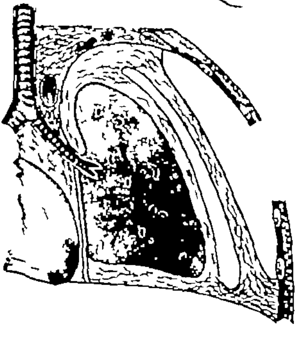
1 The approach is through a standard postero-lateral thoracotomy with the patient lying on the unaffected side and the arm pulled well forwards. This incision will give reasonable access to both the apex of the thoracic cavity and the diaphragmatic aspect (the two most difficult regions to mobilize). The trapezius and rhomboideus major behind and the latissimus dorsi and serratus anterior in front are divided in the line of the skin incision





Entry into extra-pleural layer

2 The fifth or sixth rib is resected sub-periosteally from the neck to the mid-axillary line and the posterior layer of periosteum is incised longitudinally. The extra-pleural layer is entered by blunt dissection with the finger and the outer wall of the empyema is stripped from the chest wall in all directions by a combination of blunt and sharp dissection. Considerable force is often required to complete the mobilization.



Mobilization of empyema

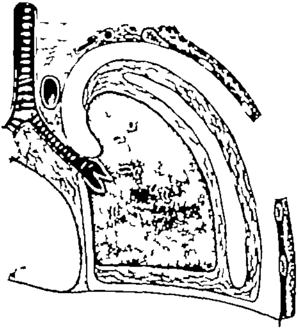
3 Due care must be exercised when stripping the outer wall from the apex of the thorax and from the diaphragm to ensure that the underlying structures are not injured. Mobilization should be carried out under direct vision if possible.

4

Stripping of outer wall

Mobilization from the mediastinum is usually easier than from the parietes as the fibrous tissue is less dense. Care must be taken not to injure the innominate vein on the left side or the superior vena cava and azygos vein on the right side as well as the vagus and phrenic nerves.

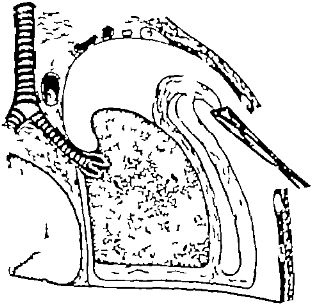
On completing the mobilization, the empyema will have been completely detached from all its parietal attachments but still remains adherent to the lung

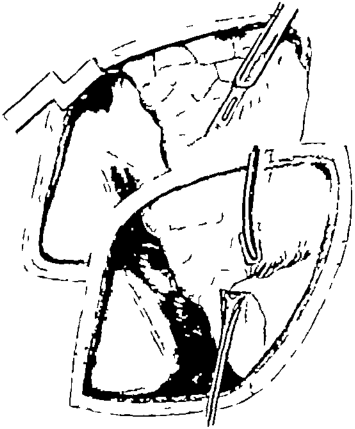


5

Stripping of inner wall

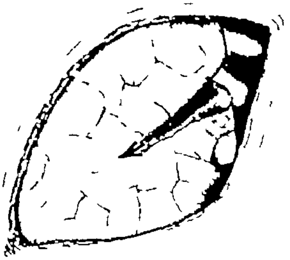
The inner wall of the empyema is now "peeled off" the lung surface. An area of minimal adherence is selected initially to provide the right plane for dissection and the mobilization is carried out gently by a combination of blunt and sharp dissection, taking care to injure the lung as little as possible





Freeing of fibrous attachments

6 Having removed the empyema sac, any remnants of fibrous tissue left attached to the lung surface are removed either by blunt dissection with a swab on a holder or by sharp dissection



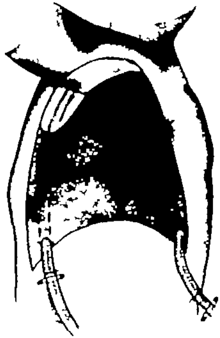
Opening of lung fissures

7 Finally the fissures between the lobes are opened up and any puckerings or bucklings of the lung are undone The lung is completely separated from all parietal and mediastinal attachments so that it is left free to expand fully

Drainage

8 At least two tubes are required for drainage purposes. One lies at the apex of the chest and is designed to remove any air which leaks from the lung surface, whilst the other removes fluid which accumulates at the base. Both are inserted through separate stab wounds They should never be brought out through the thoracotomy incision.

The wound is closed carefully in layers.



POST-OPERATIVE CARE AND COMPLICATIONS

Management

The success of the operation depends on obtaining early and complete expansion of the decorticated lung so that the space occupied by the empyema is completely obliterated and no dead space persists to encourage fresh infection or result in pleural thickening Rapid expansion of the lung is achieved by (1) applying strong suction to one or both drainage tubes (negative pressures of several inches of mercury are often required) (2) nursing the patient lying on his unaffected side (in this position the upper thoracic cavity is enlarged and increased lung expansion encouraged) (3) *the employment of vigorous breathing exercises and early ambulation.*

The tubes are removed when leakage of air and fluid have ceased, but in any case should not be retained for longer than one week. Any subsequent accumulation of air or fluid should be aspirated.

Complications

Broncho-pulmonary secretions may give rise to serious complications of atelectasis, pneumonitis or suppurative bronchitis. Coughing exercises and postural drainage are usually sufficient to keep the bronchial tree clear but if they do not suffice, catheter suction or bronchoscopic aspiration is required.

Air leakage is often considerable for several days and occasionally persists for longer periods, preventing full lung expansion. Temporary phrenic paralysis and the induction of a pneumo-peritoneum may be employed in order to reduce the space and decrease the leakage.

Re-infection of the pleural space is likely to occur if the lung does not expand to fill the pleural cavity completely Infected pockets should be treated by repeated aspirations and the instillation of antibiotics drainage may be required if aspirations fail to control the infection.

[The illustrations for this Chapter on Decortication—Pleurectomy Excision of Empyema were drawn by Mr F Price]

Bibliography

Eggers, C. (1923) *Ann. Surg.*, 77 327
Price Thomas, C., and Cleland, W P (1945). *Lancet*, 1, 327
Sarot, I. A. (1949) *Thorax* 4, 173.
Sellors, T H., and Cruickshank, G. (1951) *Brit. J Surg.*, 38, 411

EXTRA-PLEURAL PNEUMONOLYSIS

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PRE-OPERATIVE

Aim of operation

The operation is designed to mobilize and relax the upper portion of the lung by separating it from the apex and the chest wall in the extra-pleural plane. The relaxation is maintained by refills of air into the space so created.

Indications

The operation was used extensively in the treatment of pulmonary tuberculosis, before the advent of streptomycin, in patients where it was not possible to obtain an effective intra-pleural pneumothorax and where the disease was such that a thoracoplasty would have carried exceptionally high risks.

The position has been considerably altered since the introduction of antibiotics, which result in retrogression and stability of the disease in the majority rendering them fit for either resection or thoracoplasty

Contra-indications

The operation is not advised for patients with very large tension cavities, solid tuberculous lesions or very tough and fibrotic apices.

Pre-operative preparation

All patients should have an adequate period of treatment with rest and chemotherapy before the operation is undertaken. Such treatment should be employed preferably for a minimum of 3 months or longer if the patient is improving clinically or radiologically

Post-operative complications are reduced if the patient can be rendered non-toxic, sputum-free and sputum-negative before operation.

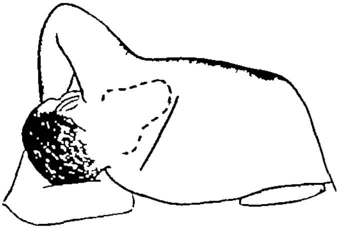
Breathing coughing and arm exercises are indicated before operation.

Anaesthesia

Local anaesthesia is impracticable owing to the difficulty in controlling coughing during the mediastinal mobilization.

General anaesthesia with intratracheal intubation and using thiopentone a relaxant, nitrous oxide and oxygen is the method of choice, and must be deep enough to reduce the tendency to cough during mobilization. This tendency can often be reduced by the injection of local anaesthetics into the vagus nerve and sympathetic trunk as they are exposed during the mobilization. Controlled respiration is an advantage as lung movements can be kept to a minimum when mobilizing difficult or dangerous areas.

THE OPERATION



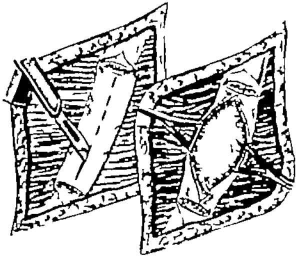
The incision

1 The patient is placed in the lateral position with the shoulder pulled well forwards.

An oblique incision is made in the interval between the vertebral border of the scapula and the vertebral spines overlying and parallel to the fourth rib

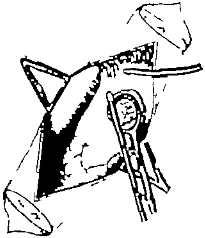
The trapezius and rhomboid muscles are divided in the line of the incision and the fourth rib is exposed from its neck to the posterior axillary line.

A short segment (5–6 inches) of the fourth rib is carefully resected sub-periosteally



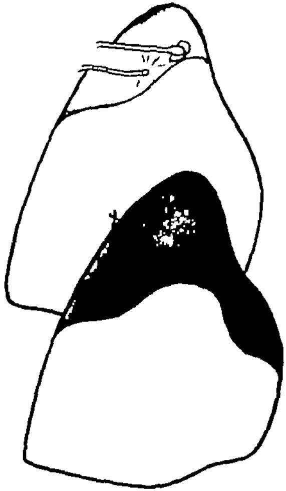
Incision through periosteum and pleura

2 The posterior layer of the periosteum is carefully incised throughout its exposed length and the plane between the periosteum and the parietal pleura is opened and developed in all directions.



Extra-pleural separation of lung

3 The separation of the lung extra-pleurally is carried out mainly by gentle blunt dissection under vision with a malleable light using a swab on a holder Occasional bands may require division with knife or scissors. Especial care is required when freeing the apex to prevent damage to the subclavian artery innominate vein or brachial plexus.



Extent of lung relaxation

4 The lung is freed from the apex and the superior mediastinum and from the parietes until the diseased area of lung has been relaxed as judged by the feel of the lung and estimated from the pre-operative x-ray

All bleeding points are very carefully sealed before closing The wound is closed very carefully to ensure an airtight space. No drainage tube is used.

POST-OPERATIVE CARE AND COMPLICATIONS

The success of the operation depends on maintaining the relaxed state of the lung with refills of air into the space. The frequency and size of the refills can only be judged by taking frequent radiographs. The first film is taken immediately after the operation.

Haemorrhage or serious oozing into the space are not infrequent complications and may if excessive, cause further stripping of the lung from the parietes. Any excessive accumulation of fluid should be removed by aspiration repeated as necessary

Apart from haemorrhage, the only other important complication is infection of the space with either pyogenic organisms or tubercle bacilli.

Pulmonary complications (atelectasis or spread of infiltration) are not very common.

[*The illustrations for this Chapter on Extra-pleural Pneumonolysis were drawn by Mr F Price*]

Bibliography

Brock, R. C. (1938) *Brit J Tuberc* **32**, 178
Reid, H. (1946). *Thorax*, **1**, 211
Sellors, T H. (1938) *Brit. J Tuberc.*, **32**, 182.

EXTRA-PERIOSTEAL PLOMBAGE

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PRE-OPERATIVE

Aim of operation

Plombage is designed as a one-stage method of relaxing the apex of the lung which avoids the deformity and paradoxical movement which accompanies the more extensive forms of thoracoplasty The ribs are not removed but the lung apex is freed from the parietes, the apex and the mediastinum and is kept in the relaxed position by the use of a prosthesis. Various substances have been used with varying degrees of success and safety—they include natural tissue (fat, muscle) paraffin wax, and plastic materials (methyl methacrylate and polyethylene spheres and polyethylene sponges) The plastic materials are those most widely used

Indications

The operation can be used as a substitute for thoracoplasty it has the advantages of being a one-stage operation with minimal deformity post-operative complications are minimal and the reduction of the respiratory reserve is very small.

The operation is of particular value in patients with extensive disease or a poor respiratory reserve who are considered unsuitable for thoracoplasty or resection. In such cases the risks of the operation are, of course, higher and the chances of complete success are lower than is the case normally

Contra-indications

The contra-indications are those generally applied to collapse therapy that is, large solid lesions, large tension cavities, lesions associated with bronchostenosis or bronchiectasis and disease in the lower lobe. Few of these contra-indications are absolute, especially in the very poor-risk patient where no other procedure is practicable.

It is generally considered inadvisable to use a plomb in patients with a considerably thickened and tough apical pleura where mobilization has been difficult owing to the risks of tuberculous infection in the plomb space. It is also inadvisable for similar reasons, to use a plomb in patients with large cavities at the apex where there is only a narrow rim of lung tissue between the cavity and the pleura in such cases thoracoplasty is a safer operation.

Pre-operative preparation

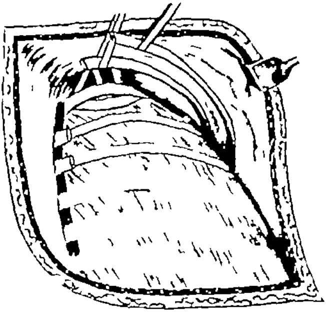
All patients should have adequate treatment with rest and chemotherapy for several months before operation. Maximum improvement in the general and radiological condition is desirable and the advantages of obtaining sputum conversion before operation have already been indicated.

Full investigations with tomography and often bronchography and bronchoscopy are desirable before deciding the type of surgical treatment to be employed in any particular patient. Only by such investigations can the full extent of the disease be determined and the treatment planned accordingly

Anaesthesia

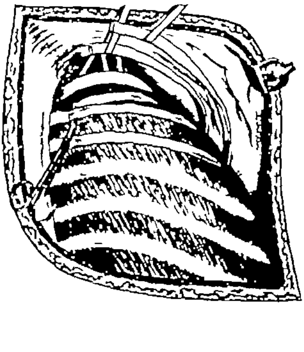
This is similar in every way to that described for thoracoplasty either local or general anaesthesia being practicable

THE OPERATION



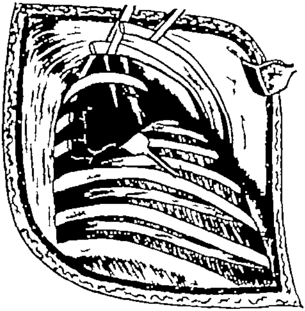
Retraction of second and third ribs

1 The incision and exposure are identical to that of the standard thoracoplasty The second and third ribs are denuded of periosteum from the neck to the mid-axillary line except from the anterior surface. The rib is then divided posteriorly but left attached anteriorly
With the second and third ribs retracted upwards the periosteum is stripped from the under surface of the first rib but the latter is not divided.



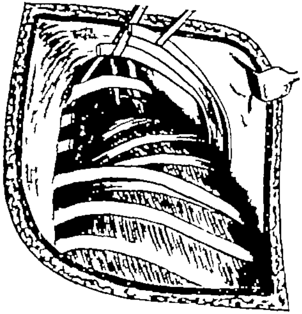
Division of intercostal muscles

2 The periosteum attached to the inner margin of the first rib is detached by blunt dissection this opens up the mediastinal plane and dissection is carried downwards as for thoracoplasty until the hilar region is reached.
The second and third intercostal bundles and muscles are divided posteriorly and left attached to the lung which is being mobilized.



Lung mobilization

3 Further ribs below the third are stripped of their periosteum except anteriorly as far down as is necessary to mobilize the diseased lung These ribs need not be divided but the bundles and muscles are detached posteriorly



Suturing of intercostal bundles

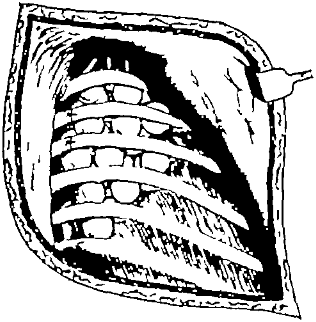
4 At the completion of the mobilization the divided posterior ends of the intercostal bundles and muscles are sutured to the anterior longitudinal ligament of the spine immediately above the mobilized lung In this way the lung and pleura are completely covered with a layer of soft tissue which acts as a pad between the plomb and the lung

5

Insertion of plomb material, closure

The apical space is now loosely filled with the plomb material of choice. This should never be tightly packed in but should merely fill the space loosely. The divided ends of the second and third ribs are drilled and sutured together thus reconstituting the bony thoracic cage.

A small catheter is inserted through a stab wound into the space for drainage. It is attached to an under water seal bottle and left *in situ* for 24–48 hours. This will prevent the inevitable accumulation of fluid leading to further mobilization and compression of the lung



POST-OPERATIVE CARE AND COMPLICATIONS

Drainage of the space is maintained for 24–48 hours. Breathing and coughing and arm exercises are given routinely. Due attention is paid to the removal of excessive bronchial secretions by postural coughing. If this should not prove effective, catheter suction or bronchoscopic suction will be required.

Complications

Post-operative complications are few: atelectasis occurs occasionally and requires treatment with postural coughing or bronchoscopy. Spread of tuberculous disease is rare: should it occur intensive chemotherapy should be instituted. Haemorrhage into the space is uncommon and usually ceases spontaneously. Transfusions should be given if blood loss is severe and aspirations performed if the drainage is not functioning. Infection of the space with pyogenic organisms occurs occasionally. Although the infection may be controllable by antibiotics, it is often wise to remove the plomb and convert into a thoracoplasty.

[*The illustrations for this Chapter on Extra-periosteal Plombage were drawn by Mr F Price*]

Bibliography

Jackson, C. A., and McCann, J J (1946). *Tubercle Lond* 37 86.
Lucas, B G B and Cleland, W P (1950). *Thorax*, 5, 248.
Wilson, D A. (1945) *J thorac. Surg.*, 17 111

PNEUMONECTOMY

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PRE-OPERATIVE

Indications

The commonest indication is bronchial carcinoma, but there are many pathological conditions which will destroy so much of the lung that it is impracticable to do any operation less than removal of the entire lung. These conditions include bronchiectasis and tuberculosis, affecting all, or almost all, segments. Occasionally benign conditions, such as adenoma, will lead to obstruction of the main bronchus, which results in peripheral suppuration, and the only satisfactory treatment will be a pneumonectomy. In the case of carcinoma, the operation usually performed will differ from that for other conditions, in that an attempt at radical excision of as much of the lymphatic drainage as possible will be included. For this reason, the majority of carcinomas coming to operation have a pneumonectomy performed; nevertheless with a peripheral lesion it is possible that lobectomy only is necessary to remove the whole tumour. In such cases the choice between pneumonectomy and lobectomy must be made when the exact location and extent of the tumour is displayed. The decision will be made for each individual case, considering carefully the patient's age, general condition, and especially the function of lung to be left behind.

In order to clear as much of the lymphatic drainage of the lung as possible, the glands around the trachea and the subcarinal group must be removed. It is also possible to divide the pulmonary vessels within the pericardium. When this more extensive dissection is carried out it is termed a radical pneumonectomy.

The radical operation is more often associated with cardiac irregularities, in particular auricular fibrillation. For this reason patients undergoing this operation should be digitalized pre-operatively.

Contra-indications

The choice of patient for pneumonectomy will depend not only on the extent and type of pathological condition of the lung affected, but also on the functional state of the other lung. As a general rule, pneumonectomy is only practical when there is a normal lung on the other side, and it is known that the function of this is adequate to sustain life and allow some reserve for activity. It must be remembered that acute infections of the residual lung after pneumonectomy may intererfere seriously with that function. A patient giving a history of repeated attacks of bronchitis will need very careful assessment; an acute attack of bronchitis following a pneumonectomy may so interfere with the function as to prove fatal.

Pre-operative preparation

The pre-operative preparation has two main aims, first to raise the patient's general health to as good a state as possible for the operative procedure, and secondly to reduce the quantity of sputum and render it as sterile as possible. The latter can be achieved by the use of antibiotics, and in localized suppurative conditions by postural drainage. Preliminary instruction in breathing control and clearing sputum is given by a physiotherapist; the smoothness of the post-operative period will depend much on the patient's ability to clear sputum from the bronchial trees.

In tuberculosis, it has now been shown that a course of chemotherapy of several months immediately before operation is extremely valuable in reducing the incidence of complications, and especially bronchopleural fistula. If a definite diagnosis of tuberculosis has been made, chemotherapy should be given for at least 2 months before operation.

Anaesthesia

General anaesthesia is used, and is nearly always combined with some muscle-paralysing agent. Induction is with a small dose of Pentothal, followed by nitrous oxide and oxygen. The part the anaesthetist has to play is a very

important one as he is responsible for arranging his anaesthetic apparatus in such a way that there is a minimum risk of sputum from diseased parts of the lung entering normal aerating bronchi.

Position of patient

Most surgeons do lung resections with the patient in the lateral position. There are some however who prefer the face-down position, as this allows secretions from the lungs during operation to run by gravity through the trachea and endotracheal tube rather than back into the lungs. If the patient has a large quantity of sputum and the lateral position is chosen it is essential to use some endobronchial apparatus to shut off that part of the lung which is suppurating from the rest of the bronchial trees.

Sequence of dissection

Owing to pathological changes there is much variation in the ease of the operation some steps may prove difficult in one case and easy in another As a general rule it is wise to start the dissection in the easiest area, provided that operability has been definitely established. In the illustrations that follow the sequence adopted is arteries, veins and finally bronchi, but this can be altered if it is considered safer in an individual case. Whilst it is usual to ligate arteries before veins to avoid trapping blood in the lung which is to be removed, in malignant disease it has been recommended that the veins should be ligated as the first step to prevent embolism of tumour fragments during manipulation of the lung

If there is pus in the lung and the bronchus is not securely closed off from the trachea, it is imperative that the bronchus clamp be applied at the earliest opportunity

Prevention of bronchopleural fistula

If the bronchial stump does not heal satisfactorily the most serious complication of pneumonectomy a broncho-pleural fistula, will result. The technique of division and suture of the bronchus is therefore most important. The bronchus must always be divided flush with the trachea so that no blind stump is left. The method described does not involve the use of a clamp on the bronchus where it is to be sutured, as it is believed that any crushing even with a light clamp damages the tissue and interferes with healing Stainless steel wire is used as it is thought to be the least irritant material available and retains its tensile strength in the tissues. Monofilament wire is less likely to tear the membranous part of the bronchial wall than is braided wire, although it requires practice to handle as it kinks readily Some surgeons cover the stump with pleura. This is not possible when a radical operation is done, as all available soft tissue in the vicinity should have been removed. It is not material whether a continuous or interrupted suture be used as long as accurate apposition is achieved.

The phrenic nerve

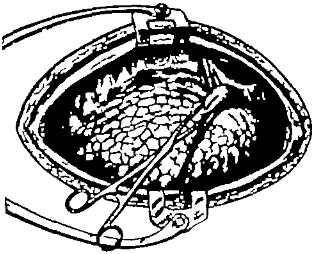
If the phrenic nerve is crushed at operation the diaphragm will rise in the post-operative period to a remarkable degree. This certainly reduces the dead space left, but has certain disadvantages It does to some extent interfere with the action of the diaphragm on the other side and results in greater displacement of the abdominal viscera. It is not unusual for patients to complain of dyspepsia after pneumonectomy especially after left-sided operations. The phrenic nerve is therefore only crushed when there seems to be a special risk of a post-operative empyema and reduction in size of the pleural cavity becomes more important than other considerations.

THE OPERATIONS

LEFT PNEUMONECTOMY

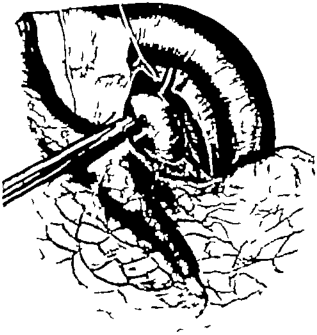
Exposure

1 The chest has been opened by the removal of a length of the sixth rib A Price Thomas rib spreader is *in situ* splaying the chest wall and exposing a free pleural cavity in the lower half of the chest. In the upper part of the chest anteriorly there are multiple pleural adhesions which can be divided with scissors. Posteriorly the adhesions are so dense that it is necessary to strip the lung from the chest wall in the extrapleural plane. An incision has been made into this plane and finger dissection will separate the lung from the chest wall, the lung being covered by the thickened and fused visceral and parietal pleura care must be taken in doing this not to damage the intercostal vessels When it is necessary to do an extrapleural strip anteriorly the phrenic nerve and internal mammary vessels are similarly endangered. Dissection in this plane always results in considerable blood loss.



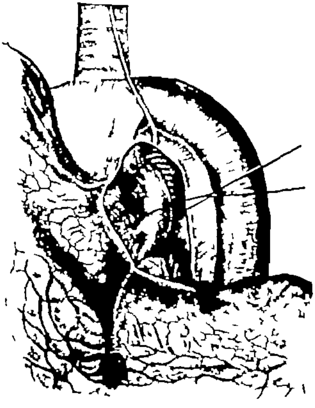
Dissection

2 Having palpated the lung and examined the hilum and mediastinum to determine oper ability the dissection is started posteriorly at the upper limit of the hilum. The pleural reflection is incised along the left hand dotted line, following the pulmonary artery except for malignant disease when the incision follows the inner border of the aorta, along the right hand dotted line. To expose this the upper part of the lung has been retracted down and forwards.



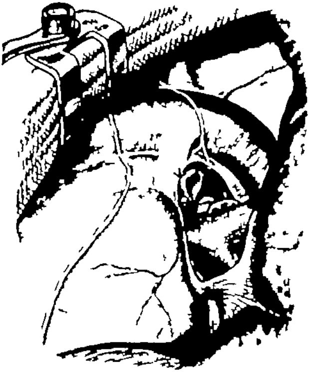
Tying off the pulmonary artery

3 Dissection is continued around the pulmonary artery proximal to its first branch and close to the ligamentum arteriosum. The vagus nerve has been cut distal to its recurrent laryngeal branch A strong thread ligature is passed round the artery and tied as close to the ligamentum arteriosum as possible



Anatomical variations of the pulmonary artery

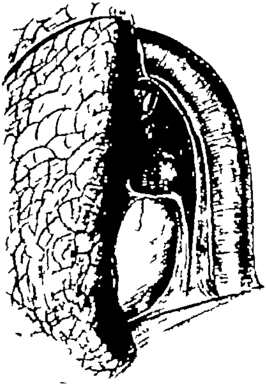
4 There is considerable anatomical variation in the branching of the pulmonary artery In the case illustrated the first branch comes off so close to the site of proximal ligature that this branch has been ligated and divided separately It is often wise to apply two proximal ligatures as a safeguard against slipping but if an adequate cuff of vessel can be left beyond the ligature this is not necessary



Exposure of hilar anterior aspect

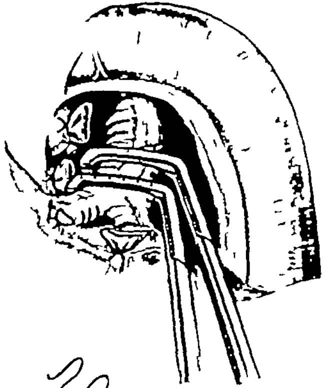
5 Having divided the pulmonary artery between ligatures, the lung has been retracted backwards to expose the anterior aspect of the hilum The superior pulmonary vein has been dissected out and is then divided between ligatures.

As in the case of the artery either two proximal ligatures or one together with a transfixion stitch safeguards against slipping



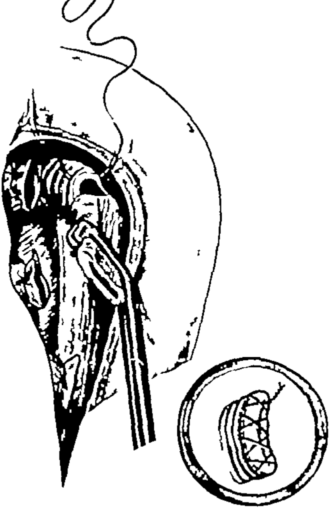
Exposure of inferior pulmonary vein

6 The inferior pulmonary vein is being exposed from behind. The lung is retracted forwards. The pulmonary ligament has been divided it may carry a vessel or two which will require ligation. The pericardium comes into view behind the lung



Clamping the bronchus

7 The lung is now only held by the bronchus, which has been cleared by division of adventitious tissue around it and then clamped Various models of clamps have been devised it is preferable to use clamps with teeth to prevent slipping A bronchial artery is shown coming from the aorta. This has been ligated and will be divided. The bronchus is divided between the clamps and the lung removed.



Bronchus incision

8 The bronchus incision has been started at the site carefully chosen close to the carina, so that there will be no blind stump after suture, but leaving enough bronchus to close without narrowing the lumen to the other lung Whilst the bronchus is open the sucker is used to prevent any blood being aspirated into the respiratory system. At first only part of the bronchus is incised and then closed, in order to avoid at any time having a large leak of anaesthetic gases, which could prevent the anaesthetist inflating the other lung.

Inset—The appearance of the bronchus after closure. The method of bronchial closure is discussed in the pre-operative section under the heading Prevention of bronchopleural fistula"

RIGHT PNEUMONECTOMY

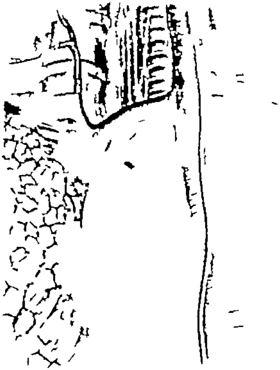
Anatomical appearance

9 On the right side the anterior aspect of the hilum is usually dissected first. The pulmonary artery has been identified overlying the bronchus and below it the superior pulmonary vein. The uppermost tributary of this vein is seen to cross superficial to the artery It is often easier to ligate and divide the vein first and then the artery can usually be ligated and transfixed proximal to its first division without difficulty

Division of main vessels

10 The aspect is the same as in the previous illustration after division of all the main vessels. The inferior vein is usually more easily approached from behind, but after dividing it the bronchus is approached from in front and above as shown.

The clamp is placed with care so that on dividing the bronchus proximal to it there is enough of the main bronchus to take the sutures, but the line of section is sufficiently close to the carina to avoid leaving any bl stump

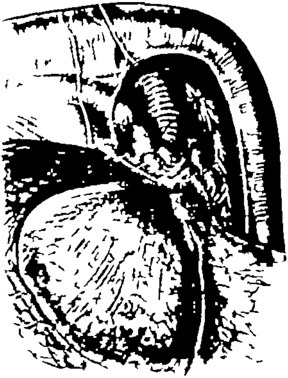


LEFT RADICAL PNEUMONECTOMY

Anatomical appearance

11 The wider pleural incision for clearance of lymphatics is shown. The pulmonary artery is not involved in its proximal course and so has been ligated outside the pericardium in this case.

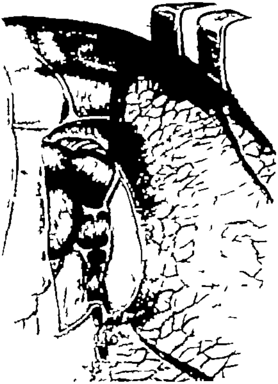
The site of division of the vagus immediately distal to the recurrent laryngeal nerve is shown. The oesophagus is clearly seen behind the bronchus as the lymphatic tissue overlying it is being swept away with the lung



Anterior aspect

12 This shows the anterior aspect of the left lung hilum, with the pericardium opened for intrapericardial ligation of the vessels. The artery has been ligated, and dissection started between the veins, which are joined by a mesentery-like reflection of pericardium.

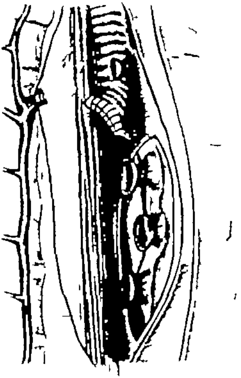
In some cases the two veins unite before entering the heart. If the growth is spreading along the course of those veins it may be necessary to excise a portion of the left atrial wall.



RIGHT RADICAL PNEUMONECTOMY

Posterior aspect of hilum

13 The posterior aspect of the hilum is shown after incision into the pericardium. When the vessels have been divided, the mediastinal pleura will be incised further up the azygos vein, which will be ligated as it enters the superior vena cava, and a portion of it removed with the lymphatics around the trachea.



Final appearance

14 This shows the final appearance after a right radical pneumonectomy The three great vessels have been divided within the pericardium. Below the sutured bronchial stump the site from which the subcarinal lymph glands have been removed is shown with the left main bronchus in its floor By retracting the superior vena cava forwards it has been possible to remove the glands lying anterior and lateral to the trachea for some distance above the azygos vein.

On the right side, the pericardium is best left unsutured. On the left, however if the defect in the pericardium is large the heart may prolapse into the pleural cavity and it is therefore necessary to suture the pericardium. Adequate space must be left between the sutures to allow free drainage into the pleural space or cardiac tamponade might develop

POST-OPERATIVE CARE AND COMPLICATIONS

Drainage

In most cases drainage is unnecessary if there is much bleeding from the chest wall at the end of the ope however it is essential. It should be through a large sized intercostal tube placed dependently though not extremity of the costophrenic sulcus lest the tube should be occluded by the rising diaphragm. It is connecte water seal to prevent air entering the chest Drainage has disadvantages. It is always painful, and when the p coughs after operation part of his energy is wasted in blowing through the drainage tube. This can be avoided by clamping the tube and only releasing the clamp for drainage for a few minutes each hour The seal drain is kept *in situ* for about 2 days, depending on the quantity of blood-stained fluid which drains do tube Once the tube has become blocked with clotted exudate, it can serve no useful purpose and should moved. In removing all drainage tubes from the chest it is important not to allow air to enter the chest, whic can be achieved by removing the tube smartly applying a dressing and then massaging around to bring the surfaces together along the drainage track. The skin is then closed by tying the mattress stitch which ha placed at the time of operation.

In the post-operative course morphine derivatives, such as pethidine, will be required and should be given frequently but in small dosage. It will then be found that the patient gets adequate rest, but is never suffi comatose to fail to cough when there is secretion in the bronchial tree requiring expectoration. One of the important features in the post-operative period will be to encourage the patient to clear such secretion and out. Atelectasis of part of the remaining lung is not common, provided patients are not too heavily sedate operation.

Bronchopleural fistula

The most serious complication of the operation is the breaking down of the suture line of the bronchus usually results in infection reaching the pleural cavity from the bronchial tree and thus in a total empyem commoner after right-sided pneumonectomies than left, probably because on the left side the bronchial sutu recedes deeply into the mediastinum and is partially covered by the surrounding tissues.

This complication occurs most commonly in the course of the first fortnight, but in tuberculous cases it n much delayed. It is often heralded by a little blood-stained sputum for a day or so The actual breakdown mea allows air to enter the pleural cavity and the fluid in the pleural cavity to enter the lung, if its level in the thorax is above that of the hole in the bronchial tree. The other lung will immediately be flooded with thi and the patient will drown very rapidly The nursing staff should be instructed that, in the event of the p suddenly coughing up a quantity of sputum stained with old blood, he should immediately be laid on his ope side and kept there until the fluid has been aspirated, or drained from the pleural cavity

Small pleural fistulas sometimes heal without special treatment, but a large fistula rarely does so In such a c pleural cavity should be drained as soon as possible, or alternatively operation performed to repair the immediately Such operations often prove unsuccessful, particularly if they are not carried out immediately A inevitable sepsis makes successful repair of the bronchus very difficult, and unlikely to hold permanently A thoracoplasty attempting to obliterate the whole residual pleural space is sometimes called for and can be d one stage as it does not produce undue paradoxical movement when there is no lung on the side of operatio

[*The illustrations for this Chapter on Pneumonectomy were drawn by Mr R. N Lane*]

Bibliography

Belcher J R., and Grant, I. W B (1955). *Thoracic Surgical Management*, 2nd Ed. London Baillière, Tindall and Cox.
Boyden, E. A. (1955) *Segmental Anatomy of the Lungs*. London Blakiston.
Brock, Sir Russell, and Whytehead, L. L. (1955). "Radical Pneumonectomy for Bronchial Carcinoma." *Brit J Surg*., **43**, (
Overholt, R. H., and Langer L. (1949). *The Technique of Pulmonary Resection*. Blackwell.

LOBECTOMY

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PRE-OPERATIVE

Indications

As for pneumonectomy the three common conditions requiring a lobectomy are carcinoma, bronchiectasis and tuberculosis. The selection of cases of carcinoma of the bronchus for lobectomy is discussed under pneumonectomy and more consideration is given to tuberculosis under segmental resection.

Cases of bronchiectasis require accurate anatomical pre-operative assessment depending on good bronchograms which show all the segmental and subsegmental divisions. Once the anatomical extent of the disease is known, it is possible to decide whether the patient's symptoms and prognosis without operation justify operative treatment.

Bronchiectatic change in the bronchi cannot be felt or seen at operation unless associated with other pathological states such as atelectasis or pneumonitis thus the extent of the operation must be planned beforehand. As a general rule all bronchi showing dilatation on the bronchograms should be removed, but a moderate degree of dilatation especially associated with atelectasis may be a reversible condition. Whilst the aim should be to leave all normal bronchi, the distribution of the disease is not usually strictly lobar and there may be perhaps one segment of a lobe which has normal bronchi whilst the remainder is bronchiectatic.

The decision whether to remove or leave the normal segment is based on the following facts (1) if, after separating the abnormal part of the lobe, the remainder is a very small segment (2) if there is much air leak from its raw surface and (3) particularly if it does not readily remain inflated. However apart from the functional benefit from leaving a normal segment of lung, it has a space-filling function, thereby reducing the over-distension to which the residual lung tissue must be subject after any resection operation. Clearly if the disease is bilateral and widespread, every effort must be made to preserve even small functioning segments

One of the less common conditions requiring lobectomy is lung abscess. Twenty years ago if surgery was required for lung abscess it was drained by a similar operation to that for drainage of empyema, extending through the fused pleura to within the lung With the antibiotic agents available today such treatment is very rarely required, but, after a prolonged course of antibiotic treatment, one is occasionally left with a lobe containing a cavity of considerable size and with little or no function. Such a cavity is a potential danger to the patient as infection may light up in it. This is particularly true of the lower and posterior parts of the lung where drainage from the cavity to the bronchial tree is not aided by gravity In such cases lobectomy or occasionally other resections may be required. The operation should be postponed until the maximum benefit from antibiotics has been achieved.

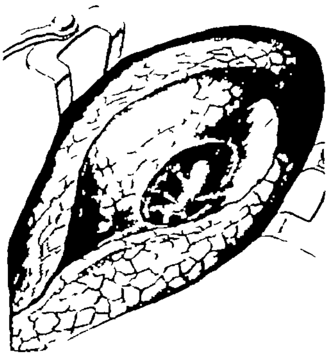
Pre-operative preparation

The same principles enunciated under pneumonectomy apply to lobectomy In bronchiectatic cases with large amounts of sputum an intensive course of postural drainage and the intelligent use of antibiotics are essential.

Bronchiectasis is frequently associated with nasal sinusitis. If there is gross suppuration in the upper respiratory tract, it is wise to postpone operation until it can be controlled. This often entails antrum puncture washouts. More extensive surgery for the nose is better left until after the lung resection, as nasal infection is likely to recur until the infected sputum has been reduced by the chest operation. The nasal condition will then often improve spontaneously and therefore more extensive surgery will become unnecessary

THE OPERATIONS

There are many variations in the broncho-vascular patterns in the lungs. The illustrations below depict arrangements of the vessels found commonly but it is essential when resecting a lobe or segment of lung to expose the hilar structures and make sure which vessels lead to and from the pathological segment to be removed.



LEFT LOWER LOBECTOMY

Pulmonary artery and vein

1 The fissure in this case is almost complete and little dissection in its depth was required to reveal the pulmonary artery and its branches. The branches leading to the lower lobe are divided between ligatures. The inferior pulmonary vein is approached from the posterior aspect as described under Pneumonectomy (Part V page 80) If a tributary from the lingula of the upper lobe drains into it this should be left intact and the rest of the vein tied between ligatures.

The bronchi

2 After division of the arteries the bronchi are seen, and sufficient clearing must be done to determine whether the whole lower lobe bronchus can be divided in one without obstructing the upper lobe bronchus. If the bronchus to the apical segment of the lower lobe comes off high up it must be dealt with separately to leave the upper lobe bronchus unobstructed. A clamp is shown applied to the basal divisions of the lower lobe bronchus. This prevents any septic contents of the bronchi of this lobe being spilled. The apical bronchus is clamped in the same way The bronchi are then divided proximal to the clamp and sutured with wire as in pneumonectomy A sucker is used whilst the bronchus is open to minimize contamination of the operative field, and to avoid blood entering the respiratory system.

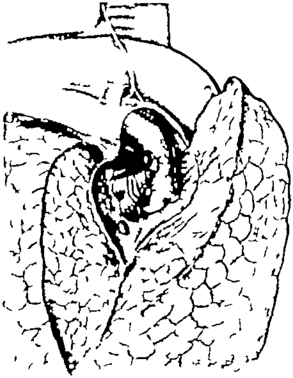
LEFT UPPER LOBECTOMY

Arterial branches of upper lobe

3 The upper part of the fissure has been developed to display the arterial branches to the upper lobe—in this case only three, the first of which rapidly divides into two. These are divided between ligatures

Retraction of pulmonary artery and upper lobe

4 The pulmonary artery and upper lobe can now be retracted to show the upper lobe bronchus which nearly always branches into two main divisions. The vein draining the apex of the lung is just visible running on to the anterior aspect of the hilum.

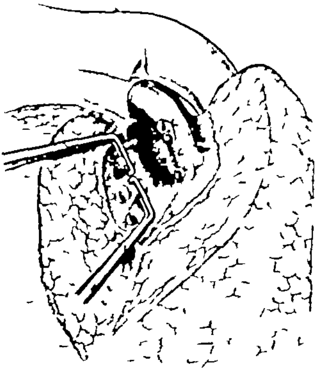


Closure of bronchi and division of superior pulmonary vein

5 A clamp or clamps are used to close and hold the bronchi distal to the line of section. The wire sutures are shown in the bronchus proximally.

Either at this stage or earlier the superior pulmonary vein is divided from in front. Here again it is necessary to ascertain that there is no tributary from the lower lobe which if present should be preserved.

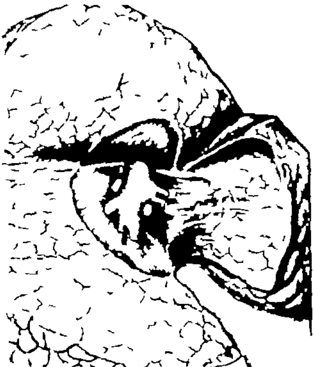
Once all the vessels and bronchi to the lobe have been divided, gentle traction on the bronchial clamps will expose and stretch adventitious tissue holding the lobe and this is divided with scissors.



RIGHT LOWER LOBECTOMY

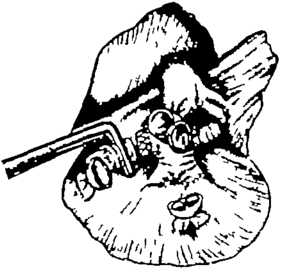
Exposure of the artery

6 The fissures have been dissected throwing the middle lobe forwards and exposing the artery. In this case the middle lobe artery divides into two immediately but it comes off sufficiently high to allow the whole lower lobe artery to be tied below it. If the apical lower artery comes off opposite the middle lobe artery it has to be ligated separately.



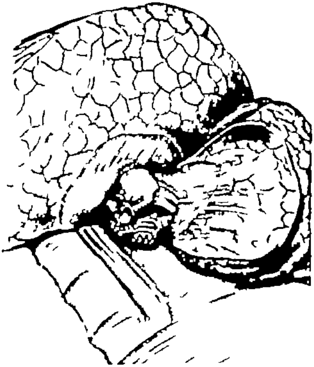
Division and closure of bronchioles

7 The lower lobe artery has been divided between ligatures. The bronchus to the apex of the lower lobe has been divided, and the sutures on the proximal stump are shown. In this case the middle lobe bronchus is seen to come off so low that it was not possible to close the whole lower lobe bronchus in one suture line without obstructing the middle lobe bronchus.



After removal of lobe

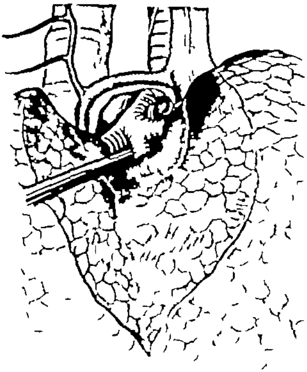
8 The lobe has been removed and the bronchial suture lines are shown. The ligature on the inferior pulmonary vein which was approached from behind has retracted out of sight.



RIGHT UPPER LOBECTOMY

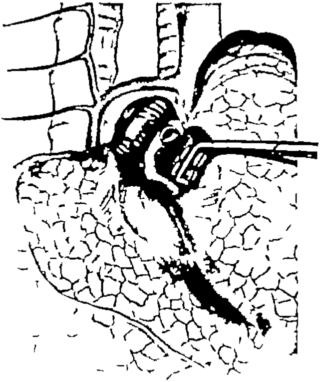
Ligation of artery to upper lobe and dissection of superior vein

9 The hilum is approached anteriorly The main artery to the upper lobe is shown ligated. The superior vein is seen to cross in front of it and requires dissecting to show the origin of its tributaries. It is usual for the middle lobe to drain into this vein.



Exposure of upper lobe bronchus

10 The upper lobe has been retracted forwards to expose the upper lobe bronchus from behind. A clamp has been passed beneath the bronchus to make room for the special bronchial clamp which will be applied immediately distal to the selected site for division of the bronchus. The bronchus should be cleared of adventitious tissue by swab dissection before applying the clamp

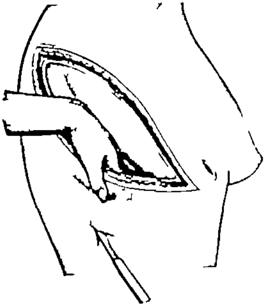


Division of the bronchus

11 The bronchus has been divided and sutured flush with the main bronchus. Retraction of the bronchi reveals a second branch of the pulmonary artery going to the upper lobe. This is a common arterial pattern.

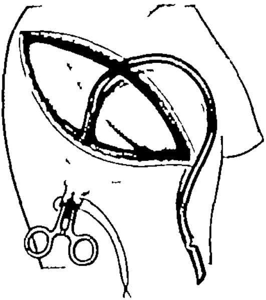
DRAINAGE

After any partial resection it is usual for two pleural tubes to be placed at operation. If at the end of the operation the residual lung is completely covered with pleura and has no air leak, a single tube may suffice The large bore dependent tube will drain bloodstained discharge and usually becomes obstructed with coagulated fluid within about two days. The fact that this dependent tube carries away the fluid should allow the smaller tube, the tip of which should lie well up in the chest, to remain patent for a longer period, and continue to allow air leaking from the surface of the lung to escape through the water-seal bottle.



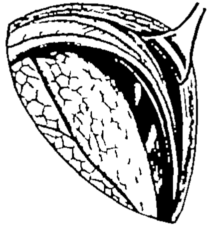
Dependent tube

12 The dependent tube is brought out through a stab incision in the posterior axillary line The fingers within the chest can select the best situation. The site of the stab incision for the upper tube is also indicated.



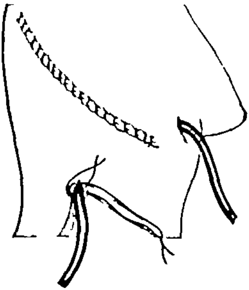
13 **Insertion of lower tube**

The tube has a side hole near its end and should protrude two or three inches up into the pleura, or the diaphragm on rising post-operatively will occlude it against the chest wall. A mattress stitch has been placed but will not be tied until the tube is removed some days later



14 **Upper tube**

The upper tube is shown within the chest. The tip is held near the apex of the pleural cavity by a loop stitch through which it will slide on removal.



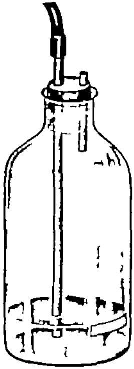
15 **Closure of wound**

The wound has been closed in layers. The second stitch at the lower stab incision traverses the tube and is tied to prevent the tube slipping. The apical tube will be fixed in the same manner

WATER SEAL

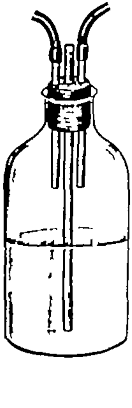
Gravity flow

16 Each drainage tube is connected to a water seal. A measured quantity of fluid is put in the bottle to cover the glass tube. This tube can be clipped off every twelve hours and the quantity of drainage measured. A label is stuck on to the bottle marking the fluid level to indicate at a glance whether the drainage has been considerable or not.



Suction pump

17 If suction is used an extra bottle can be put in between the pump and the water seal. This acts as a safety valve, which will prevent the negative pressure in the system exceeding the height between the water level and the tip of the tube, for air will be sucked down this tube if the pump creates a greater vacuum.



POST-OPERATIVE CARE AND COMPLICATIONS

Position of patient in bed

It is usual to sit all patients upright in bed after operation, as this is the position in which coughing is most effec tive and breathing easiest. However the lung tends to drop away from the apex of the pleural cavity and par ticularly after upper lobe resections some surgeons prefer to nurse their patients lying flat.

The essential aim of the post-operative course is to maintain aeration of the remaining lobe or lobes and o the residual pleural space Whilst clearing sputum from the bronchial tree to prevent atelectasis is essentially dent on the patient s own efforts, much can be done by small doses of pethidine or morphine to allay pain and b, encouragement from the physiotherapist. Manual support to the chest at the site of the incision enables the to cough effectively and he should be encouraged to do so at regular intervals, or whenever he is aware of p in the bronchi

If the pleural space is shown on x-rays to be considerable at the end of twenty four hours, many surgeons wi apply suction with a pump attached to the air outlet of the water seal bottle. It is felt that suction immediately operation may draw a constant stream of air through the leaking lung surface and prevent the holes sealing off

The dependent tube is removed when it becomes obstructed or when drainage is minimal (less than 2 ounces day) this will usually be on the second day Once the air leak through the other tube ceases, it is clipped off for few hours and then an x ray taken If this shows the lung still fully expanded the tube can be removed. In a favour able case this will also be on the second day It is occasionally necessary to aspirate pleural fluid accumulating removal of the tubes.

Complications

Atelectasis

Atelectasis can often be detected by an increase in breathlessness and confirmed by physical signs, but the prevent full clinical examination. Frequent post-operative chest x-rays are thus advisable. If an atelectatic segment not aerated by coughing within a few hours, the patient should be bronchoscoped and secretion sucked away F exhausted patients, who are unable to cough effectively secretion can be sucked from the trachea and main by passing a small tube endotracheally but this technique is not as effective as bronchoscopy

Empyema

Empyema, with or without bronchopleural fistula, is an uncommon complication. It is most unlikely to occur the lung fills the pleural cavity within a few days of operation. If pus is found on aspiration after removal of the the empyema must be drained. Such empyemas may require prolonged drainage, as the reduced volume of left after operation has to be over-distended to obliterate the space.

Other complications

There are two other rare but important complications of operations for suppurative lung conditions, namel cerebral abscess and pericarditis.

[*The Illustrations for this Chapter on Lobectomy were drawn by Mr R. N Lane*]

SEGMENTAL RESECTION OF LUNG, REMOVAL OF CYSTS

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PRE-OPERATIVE

Indications

Segmental resection is usually performed for tuberculosis or bronchiectasis. The pre-operative assessment of bronchiectasis is considered under lobectomy Removal of the lingula is often required in association with left lower lobectomy in bronchiectasis, and it was as a result of the development of this operation that the feasibility of removal of a segment of lung was first appreciated and subsequently utilized in the treatment of tuberculosis.

Space will not allow a full discussion of the indications for surgery in tuberculosis and in particular the choice between resection and collapse operations. Thoracoplasty is effective in disease which is predominantly cavitating and affecting the upper parts of the lung Resection often conserves more functioning lung and can be applied to solid or caseating foci it is also indicated for tuberculous bronchiectasis, and when the bronchi are strictured. Lately resection surgery has been used for an increasing number of cases, but there still remains a field for thoracoplasty

Antibiotic treatment

No known tuberculous lesion should be resected until the patient has had medical treatment with suitable antibiotics. The minimum period of such treatment is 2 months, but most patients will require a much longer period during which time their general resistance to the disease is increased and the number of segments of lung seriously involved is steadily reduced.

Assessment by tomography

When it is felt that maximum benefit from the more conservative methods has been obtained, it is necessary to make an accurate anatomical assessment of the extent of the disease and in particular decide which lung segments require removal. This is best done by tomography The upper parts of the lung are well shown by this method with films taken in the antero-posterior plane but the lower lobes, middle lobe and lingula can be shown best by lateral tomography If bronchiectatic change is suspected, bronchograms will also be required.

Bronchoscopy

Bronchoscopy is also frequently used in the pre-operative assessment of tuberculous patients it is the best method of revealing strictures of the larger bronchi, and will occasionally reveal active ulcerating endobronchitis, which is a contra-indication to surgery

Removal of cysts

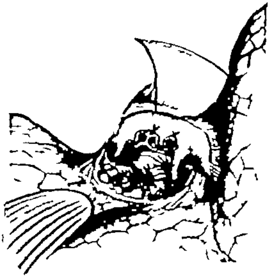
The lung may be the site of various cysts, bronchial, hydatid, emphysematous and others. Bronchial cysts should usually be removed, being often indistinguishable on radiography from tumours and liable to infection Emphysema usually affects both lungs surgery is only indicated when a single area, having become cystic, is in itself interfering with the mechanics of respiration Sometimes excision is possible, sacrificing very little surrounding lung more often the cyst must be obliterated from within.

THE OPERATIONS

REMOVAL OF THE APICAL AND POSTERIOR SEGMENTS OF THE LEFT UPPER LOBE

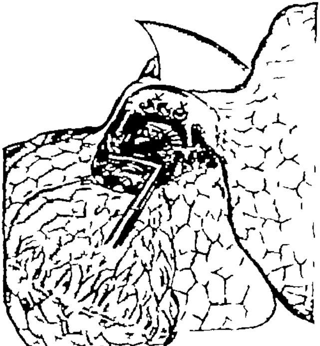
Arterial dissection

1 The hilum is approached from above and behind as for left upper lobectomy. The pulmonary artery has been dissected out from the ligamentum arteriosum well down into the fissure, so that its various branches to the upper lobe are displayed. The most proximal artery is usually a branch to the anterior segment of the upper lobe, and this is shown left intact. The next 2 branches have been identified as those supplying the segments to be removed, and have been divided between ligatures. The fourth branch in the case shown is the lingular artery and can be seen to run with its segmental bronchus.



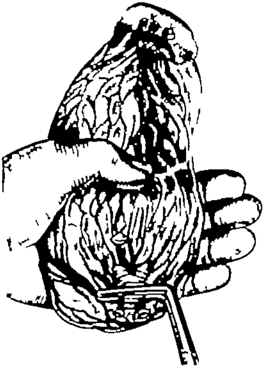
Division of bronchus

2 After dividing the arteries, the bronchus to the upper lobe is seen beneath them and can be dissected free to identify its two main divisions. The apico-posterior bronchus has been clamped distally and divided. The suture line is seen. The dissection has also revealed the apical vein, seen in the illustration just to the left of the sutured bronchus. This vein is also divided.



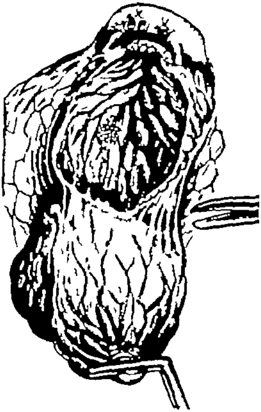
Separation of segments

3 Gentle traction on the bronchus clamp and the use of the index finger begins the separation of the segments in the intersegmental plane.
It is an advantage to have the lung fairly well inflated the collapsed segments being removed will then be easily distinguishable Should the finger transgress the intersegmental plane into aerated lung the resulting air leak will immediately reveal the error



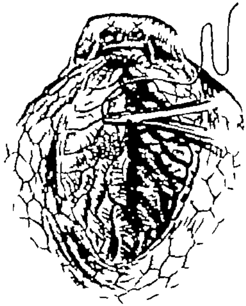
Removal of segments

4 Once the separation has started in the correct plane the segments to be removed can be rolled off by the manoeuvre shown. The "tree of intersegmental veins is visible and confirms that the separation is continuing in the correct plane. Haemorrhage is not gross and only a few tributaries of the vein require ligating



Division of visceral pleura

5 The segments being removed are now only held by the visceral pleura which is cut with scissors. Bubbles show a small air leak from the remainder of the upper lobe. A swab is then applied to the raw surface for a minute or so. On removing the swab any bronchial leaks will be visible.

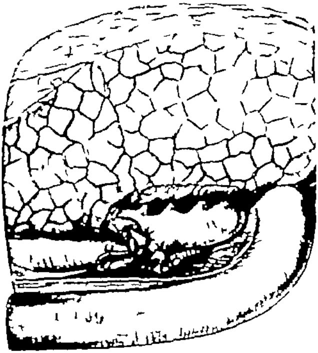


Closure of air leak

6 The site of air leak is being closed with an atraumatic suture. One or two bleeding points on the venous tree have been ligated.

The anaesthetist should inflate the lung fully to test for bronchial air leaks and to make sure that the bronchi remaining have not been obstructed.

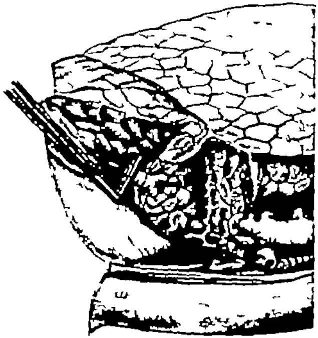
Two drainage tubes are placed as for lobectomy (Part V pages 102–108)



LINGULECTOMY WITH LEFT LOWER LOBECTOMY

Identification of lingular bronchus

7 This shows the appearance after left lower lobectomy in a case without adhesions between the lingula and lower lobe. The lingula has however been shown by bronchograms to be bronchiectatic and is to be removed. By lifting up the ligated artery the lingular bronchus can be identified.



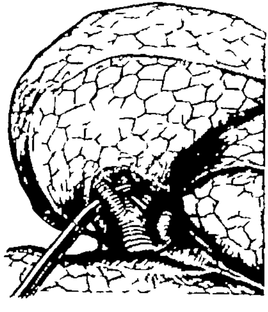
Separation of lingula

8 The lingular bronchus has been divided and sutured proximally The stump is hidden by the artery which has been allowed to fall back. The lingular artery has been divided, leaving intact a branch going to the normal lung adjacent.

Gentle traction on the bronchus clamp is separating the airless lingula from the rest of the upper lobe

REMOVAL OF THE APICAL SEGMENT OF THE LEFT LOWER LOBE

9 The pulmonary artery is seen lying in the fissure its branch to the apical segment of the lower lobe has been ligated and divided, just proximal to its division into two branches. Beneath the divided artery the bronchus is visible. The vein will be approached from the posterior aspect of the segment.



REMOVAL OF THE POSTERIOR SEGMENT OF THE RIGHT UPPER LOBE

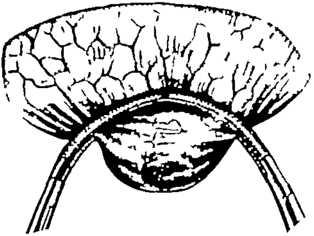
10 The bronchus has been approached from behind after separating the upper and lower lobes. The upper lobe bronchus is seen to divide into its three main divisions. A clamp has been passed round the bronchus to the posterior segment. The artery to this segment is clearly seen. It usually arises as a separate branch from the main pulmonary artery as shown.

WEDGE RESECTION

Separation of lesion

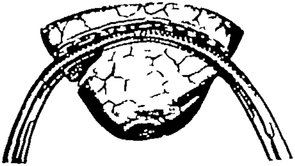
11 A small lesion lying peripherally in the lung can be excised with a wedge of lung When performing a lobar or segmental resection for tuberculosis and a suitable lesion is found in the remaining lung it is not infrequently removed by wedge resection The technique is inferior to that of segmental resection, since it is more difficult to secure the bronchi and is more bloody as the lung incision is not made in an anatomical plane. However if the lesion is small and strictly peripheral the raw surface of the lung can be oversewn without seriously limiting the re-expansion of the lung

Two light clamps have been placed to exclude a small portion of lung containing the lesion.



Suture and excision

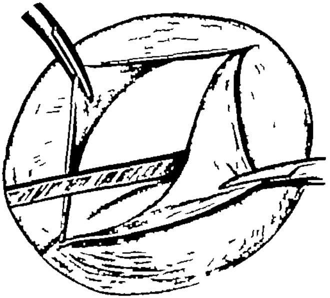
12 A haemostatic and air tight suture has been placed proximal to the clamps and the wedge is being excised.

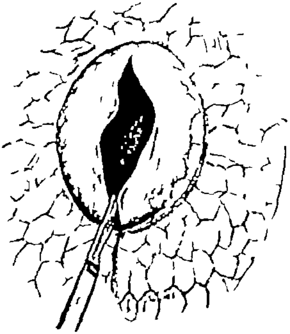


REMOVAL OF HYDATID CYSTS

13 An intact hydatid cyst can be removed without loss of lung tissue If before operation such a cyst has ruptured into the bronchial tree it soon becomes infected, and simple excision is no longer possible. The cyst must then be removed together with the surrounding infected lung by lobectomy or segmental resection.

An incision has been made down to the laminated membrane which is easily recognizable by its glistening bluish white colour The lung is being very gently separated from the intact cyst in the plane outside the cyst wall. When a third or half its surface has been freed, inflation of the lung by the anaesthetist will complete its extrusion.

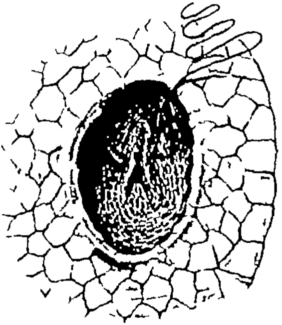




EMPHYSEMATOUS BULLAE

The incision

14 Whilst emphysema is usually a generalized disease and not amenable to surgical treatment, occasionally a solitary air-containing cyst is sufficiently large to interfere with respiratory function Such a bulla can be incised and the space obliterated from within.



Oversewing of bulla

15 The bulla is being oversewn from within special attention being paid to the sites of air leak from the small bronchi leading to it.
The anaesthetist should pay particular attention to gentle inflation to avoid tearing the lung or increasing the emphysema by too great an intrapulmonary pressure.

POST-OPERATIVE CARE

Drainage

Post-operative management generally is as for lobectomy Owing to the nature of the operation persistent air-leaks from the raw surface of the lung are more common, and it is often necessary to keep a tube in the pleura for some days. The longer this is necessary the greater the risk of developing an empyema. Some surgeons use pump suction throughout the post-operative period and if the air-leak is very great it is certainly helpful, but is better delayed for at least some hours after operation. (*See* Lobectomy Part V page 105)

Thoracoplasty

Overdistension of the lung is particularly undesirable in tuberculosis, a disease in which until recently collapse was the basis of all surgical treatment. For this reason some form of thoracoplasty is often done to reduce the size of the hemithorax to fit the residual lung This is usually performed about 8 weeks after the resection operation, but in good risk cases it can be done at the same time with little added risk. The decision whether to do such a thoraco-plasty will depend on the amount of lung tissue removed, the extent of disease in the lung left behind, and will also be indicated if there is a persistent air space in the pleura after resection.

Phrenic nerve crush

A phrenic nerve crush is an alternative method of reducing the size of the hemithorax. It is particularly useful to lower lobe resections in upper lobe resections, if employed it must be done before the lung has become adherent in the chest wall. If done at operation it reduces the effectiveness of coughing post-operatively and for this reason may be done as a separate procedure a few days later when effective coughing is not so important as there is less risk of atelectasis.

Reference

Barrett, N R. (1947) "The Treatment of Pulmonary Hydatid Disease." *Thorax*, 2, 21

OPEN HEART SURGERY

METHODS OF OBTAINING IDEAL CONDITION

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GENERAL PRINCIPLES

Cardiac surgery has made rapid strides in the last decade and it is now obligatory to obtain access to the of the bloodless heart. In addition many advantages obtain from working on the motionless heart and a method obtaining such ideal conditions now exists.

Indications

Lesions of the interatrial and interventricular septa demand direct access as do valvular defects which are n purely stenotic in type As advance in technique continues it is likely that these indications will be extended to cardiac defects other than those secondary to coronary artery disease and even in this field grafting of dise segments of the coronary vasculature may require the temporary cessation of the heart beat.

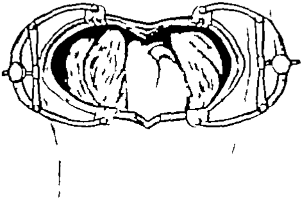
Anaesthesia

General anaesthesia with an endotracheal tube is essential and it is current practice to reduce narcotic agents o minimum.

THE OPERATION

Exposure

1 Open heart surgery requires the fullest exposure of the heart and great vessels and it is essential to open both sides of the chest. A trans-sternal incision is normally used, particular care being taken to divide the sternum in a wedge-shaped manner to ensure accurate apposition and firm reunion. Care too must be taken to secure the internal mammary vessels prior to trans-section of the sternum.

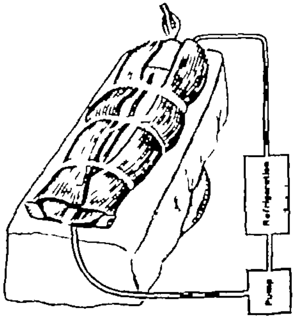


PART

Hypothermia

Technique

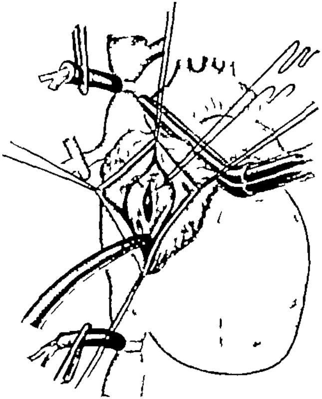
2 The general circulation can be halted for only 2 or 3 minutes before damage to vital structures ensues. If the patient is cooled to 28 C. this time limit can be extended to approximately 10 minutes before such changes occur Hypothermia is the term applied to such partial refrigeration and it is normally induced by exposing the fully anaesthetized patient to an ambient temperature of about 0 C The illustration shows such an anaesthetized patient enshrouded in a special blanket through which iced water is pumped. An alternative method is to direct a proportion of the blood stream through a coil of plastic tubing immersed in a refrigerator at -2° C.



Cardiotomy under hypothermia

3 When the reduction in temperature has been effected the heart may be isolated from the circulation for 8–10 minutes. Snares placed on the superior and inferior vena cavae prevent venous blood from entering the heart. A clamp across the roots of the aorta and pulmonary artery avoid retrograde flow Further snares may be placed around the pulmonary veins at the lung hila.

After suction has emptied the heart cavity the appropriate repair is performed within the time limit. Release of the snares will allow the heart to fill before removal of the aortic clamp Air embolism may be further avoided by filling the chest cavity with saline before completing the closure of the cardiotomy The technique demands speed and precision and restricts the field to those defects which may be successfully repaired in the few minutes available.



The heart-lung by-pass

Apparatus

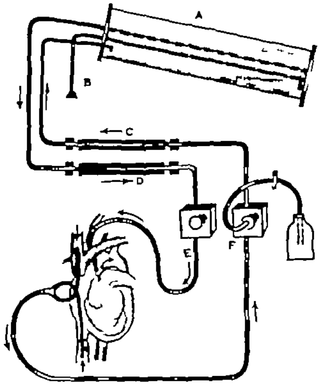
4 An alternative to the reduction of the body's metabolic demands by hypothermia is to supply sufficient artificially oxygenated blood to the vital areas to meet their demands while the heart is excluded. A device for this known as a heart-lung machine is diagrammatically represented.

Rotation of cylinder A causes blood to be spread in thin films over a large surface area and exposes these films to a mixture of oxygen and carbon dioxide entering by tube B The functions of the lung are thus imitated.

C and D are pumps which by their action drive blood from the patient's venous system into the artificial lung and from there after arterialization back into the arterial system.

E and F are tubes leading from junction boxes to and from the patient.

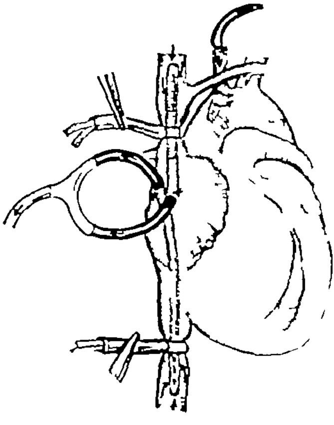
Many types of apparatus now exist to imitate the function of the heart and lungs and it is as yet too early to draw firm conclusions about the relative merits of these types.



The establishment of the extracorporeal circuit—cannulation

5 In order to establish an effective extracorporeal circulation cannulas of adequate size must be placed in the great vessels. Venous blood is most effectively removed by means of two cannulas placed into the superior and inferior vena cavae by way of the right atrial appendage. A snare around each of these veins will divert the venous return along these cannulas to the machine

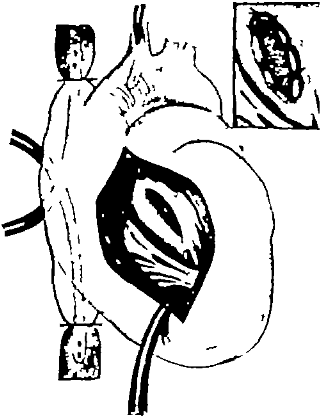
Arterialized blood is best returned to the arterial system by way of the subclavian artery of either side. This vessel may be sacrificed after use. More peripheral vessels are either too small or if large must be repaired. Drainage of blood flowing through the myocardium is of course returned to the machine by way of an intracardiac sucker



Repair of interventricular septal defect

6 After the circulation has been diverted into the heart-lung machine the heart can be isolated and the wall of the right ventricle freely incised. Suction is required to remove the coronary venous blood continually entering the right ventricle. The communication between the right and left ventricle may be closed by sewing into the aperture a plug of sponge made of polyvinyl alcohol (*inset*) This material acting as an inert skeleton is rapidly reinforced by the ingrowth of fibroblasts and is soon covered by a layer of endocardium. Its use avoids suturing under tension in a very mobile area.

The closure being complete removal of the suction will allow the heart to fill whereupon the blood flow through the heart may be re-established as soon as the cardiotomy wound is repaired.



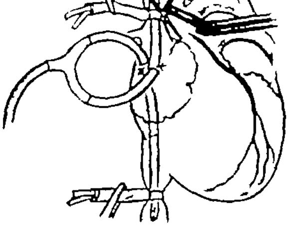
Elective cardiac arrest

7 Cardiac arrest in diastole inevitably results from an injection of potassium citrate into the root of the cross-clamped aorta so that the bulk of it enters the coronary arteries, and this arrest is maintained as long as an adequate level of potassium citrate remains in these vessels.

Normal beating is restored when simple perfusion of the coronary circulation reduces this level to normal

No damage is caused by this procedure provided it is of less than 30 minutes duration and the manoeuvre provides the ideal circumstances for open heart surgery—a motionless and bloodless field with the maximum access through a flaccid musculature.

The illustration indicates the method of inducing arrest after the heart-lung machine has taken over the circulation Resumption of cardiac activity will follow the removal of the clamp across the aorta when arterialized blood from the machine will flush out the coronary circuit.



PERICARDIECTOMY
AND DRAINAGE OF THE PERICARDIUM

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PRE-OPERATIVE

PERICARDIECTOMY

Indications

Fibrous thickening or calcification of the pericardium is not an absolute indication for pericardiectomy as abnormalities may be found on routine examination of patients showing no evidence of cardiac disability C when evidence of cardiac restriction and tamponade is accompanied by subjective and objective disability pericardiectomy indicated. The rise in the venous pressure the extent of the ascitic and pleural effusions and rapidity of their recurrence following aspiration afford some evidence of the severity of the tamponade. liver function is an indication for surgical treatment as the damage may become irreversible if the tamp remains unrelieved for too long Liver biopsy has been advocated to determine the extent of liver damage, but correlation of histological appearances and biochemical aberration may prove difficult, and the procedure is without danger

Special pre-operative preparation

If much fluid retention is present a course of mercurial diuretics is indicated prior to operation. Pleural ascitic effusions should be aspirated. Oral and dental foci of infection should be eliminated. Vitamins C and K given. The sooner breathing exercises are started before operation, the quicker will be the post-operative of full thoracic function. Operation should be delayed till the maximum diuretic effect has been obtained. final pre-operative aspirations from the serous cavities should be carried out about 4 days before operation.

It is assumed that any previous tuberculous infection of the pericardium will have reached a stage of but if a raised sedimentation rate suggests that activity persists, a pre-operative course of streptomycin is g and continued into the post-operative period. The post-operative dosage will be dictated by the operative and the histological appearances of the resected pericardium.

Breathing exercises should be encouraged and started as long before operation as possible.

Patients with liver damage tolerate morphine very badly and may become unduly depressed. Alternative medication is indicated before operation.

Anaesthesia

In the presence of the more severe degrees of tamponade the patient should be transported to the theatre propp up on four or five pillows, and may have to be anaesthetized in this position which can be maintained operation if the congestion of the head and neck cause embarrassment to the anaesthetist.

Two factors have to be borne in mind by the anaesthetist (1) the presence of liver damage and (2) both cavities may be opened during the operation.

The use of diathermy is confined to the chest wall and its employment inside the thorax is unnecessary

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No damage is caused by this procedure provided it is of less than 80 minutes duration and the manoeuvre provides the ideal circumstances for open heart surgery—a motionless and bloodless field with the maximum access through a flaccid musculature.

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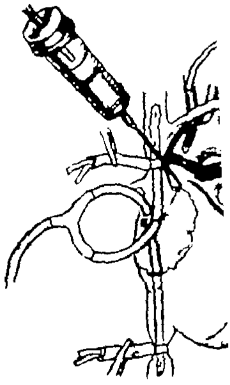

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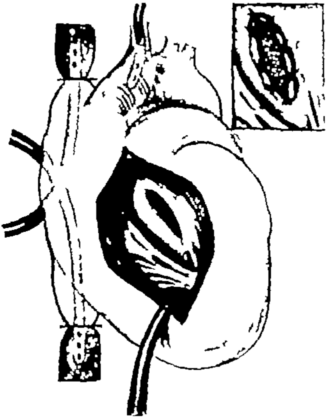

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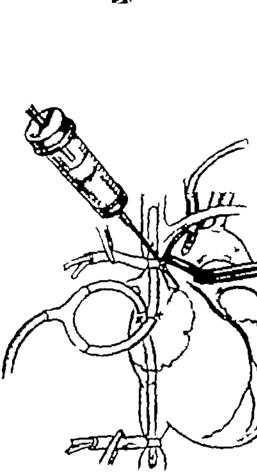

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Blood transfusion

A saline drip should be started before operation and blood should be available in case a ventricle is perforated, but routine transfusion during operation is contra-indicated by the circulatory congestion already present.

Aim of the operation

The aim of the operation is the removal of the restricting layer of fibrous tissue that surrounds the ventricles. The phenomenon of tamponade and its sequelae are largely a manifestation of ventricular restriction and contrary to previous teaching on this subject constriction of the orifices of the great veins, or the auriculo-ventricular groove plays little or no part in the functional disability that results. It is therefore not necessary to increase the risk of the operation by extending the pericardial resection to these areas

It is of the greatest importance that the left ventricle be released before the right ventricle removal of the fibrous support from the latter may result in aneurysmal prolapse and rupture of the wall of the right ventricle on the operating table

DRAINAGE OF THE PERICARDIUM

Indications

Acute suppurative pericarditis may necessitate open drainage of the pericardium but equally good results can usually be obtained by repeated aspiration of the pericardium, injection of the appropriate antibiotic into the pericardium and systemic chemotherapy The infection usually complicates a generalized pyaemia or some suppurative intra-thoracic infection.

In practice, the diagnosis is frequently missed, the signs of the suppurative pericarditis being overshadowed by those of the primary source of infection. There should be no hesitation in needling the pericardium if infection is suspected.

Drainage by aspiration

Two routes are available (1) anterior the needle is inserted through the anterior end of the fifth intercostal space, 1 inch lateral to the left border of the sternum to avoid the internal mammary artery and (2) inferior the needle is inserted upwards and backwards at an angle of 45 degrees between the xiphoid process and the left costal margin

The inferior route is to be preferred as aspiration through the anterior approach carries some risk of infecting the left pleural cavity

Loculation of the pus in the pericardial cavity readily occurs if the infection is not quickly controlled by aspiration and antibiotics. Increasing difficulty in aspiration, accompanied by evidence of continued toxaemia due to the infection, should lead to a revision of the programme. Open drainage should be carried out in order that all loculi may be adequately drained.

Anaesthesia

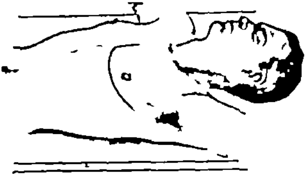
The operation can be performed under local anaesthesia if the patient is too ill to tolerate a general anaesthetic.

THE OPERATIONS

PERICARDIECTOMY

Incision

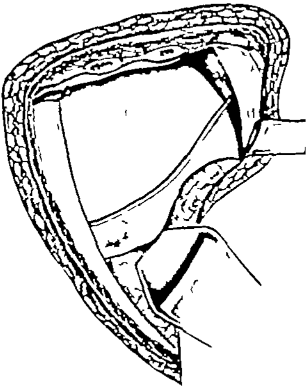
1 The patient is placed on the operating table in the dorsal supine position. A curved antero-lateral incision is made over the fourth left interspace carried laterally upwards towards the axilla and curved up medially over the sternum to the level of the third costal cartilage In the female patient the incision follows the submammary sulcus The pectoral muscle is dissected from the ribs, cartilages, and sternum and reflected upwards with the breast.



Exposure

2 Half-inch segments are now resected subperichondrially from the third, fourth, and fifth costal cartilages close to the sternum The periosteum is stripped from the upper border of the fifth rib and the left pleural cavity entered through the bed of this rib The internal mammary artery is ligated and divided. The anterior ends of the third, fourth and fifth intercostal bundles are divided. Mechanical retraction should give an adequate exposure but further costal cartilages can be divided if necessary

There is no point in attempting to perform the operation in the extra-pleural plane. The pleura is usually torn during the operation and in the event of any post-operative haemorrhage the blood is more easily aspirated from the pleural cavity than it is from the mediastinum.

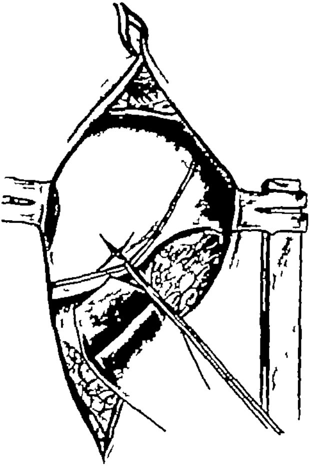


Additional exposure

3 The mediastinal pleura is unusually adherent to the parietal pericardium. The phrenic nerve is dissected free, carefully preserved and displaced backwards towards the hilum of the lung

The restriction of ventricular activity is immediately obvious. A cruciform incision is made with great care into the thickened parietal pericardium over the left ventricle and deepened till the edges of the incision spring apart. Using the corners of the flaps for retraction, a plane of separation is sought beneath them by gentle finger dissection or with a small swab on a holder The interventricular branches of the left coronary artery are constantly sought, to obviate their damage and as a guide to ventricular topography

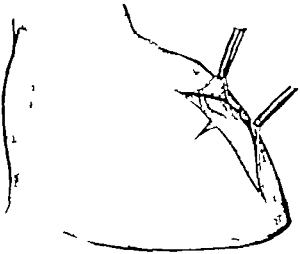
Whether the plane of cleavage corresponds to the original pericardial cavity or runs between the visceral pericardium and the myocardium is not easy to determine. There may still appear to be a thin layer of fibrous tissue overlying the myocardium, but this appears to play little part in restricting the ventricles and any attempt to remove it incurs the risk of damage to the coronary vessels or perforation of the myocardium.



Left ventricle

4 The pericardial incisions are extended and the plane of separation developed over the left ventricle. As the ventricle is released from its fetters so the amplitude of cardiac movement increases dramatically the heart literally jumps for joy The anaesthetist may detect an immediate improvement in the patient's circulation.

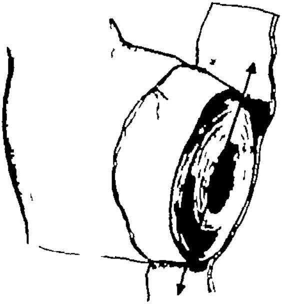
The raised flaps of thickened pericardium should not be excised till the dissection is complete. The myocardium is atrophic as a result of disuse and may be perforated by the dissecting finger or instrument. The perforation can be closed by suturing a flap of thickened pericardium down to the myocardium, provided the flaps have been retained against this eventuality



Right ventricle

5 After the left ventricle has been uncovered the pericardial resection is extended over the right ventricle. Ideally the whole of the ventricular pericardium should be resected but this is seldom possible

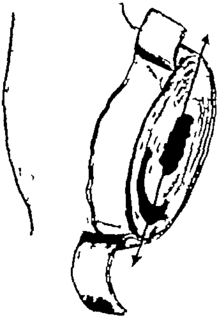
The pericardial resection must be pursued with extreme caution to avoid damage to the coronary vessels. The restricting membrane is usually the outermost layer and to carry the dissection too deep in an effort to resect visceral pericardium may end in disaster

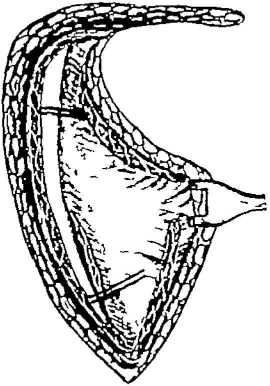


Further resection

6 A satisfactory functional result can be obtained by carrying the resection beyond the meridian" of the ventricles in all directions, so that any contraction of the remaining portion of pericardium tends further to uncover the ventricles. It is unnecessary to extend the resection beyond the auriculo-ventricular groove, or to include the orifices of the great veins.

The calcified pericardium is removed in the same manner The calcification may extend into the myocardium. The dissection should be discontinued in this area in view of the risk of perforating the ventricle, and the islands of calcified pericardium thus abandoned will probably not jeopardize the success of the operation.



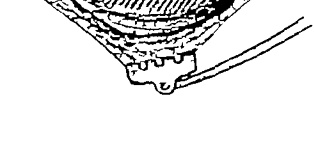


Closure

7 An intercostal catheter is inserted into the left pleural cavity for later attachment to an underwater seal. The fourth and fifth ribs are approximated by pericostal sutures and the intercostal layer repaired. The divided costal cartilages will not require any fixation. The pectoral muscle is sutured back into position by interrupted or continuous sutures and the skin incision closed.

OPEN DRAINAGE OF THE PERICARDIUM

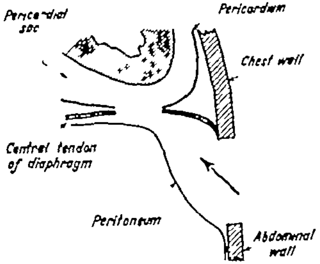
8 A short transverse incision is made over the fifth costal cartilage. The whole of this cartilage is resected sub-perichondrially. The internal mammary artery is ligated and divided. The pericardium is then opened through the bed of the cartilage taking care to avoid opening the left pleural cavity.
The finger is then inserted into the pericardial cavity to ensure that no loculated collections of pus remain undrained. Drainage is maintained by several strips of soft rubber drain securely anchored with safety pins, but owing to the complicated nature of the pericardial cavity loculation is prone to occur especially posterior to the heart.



Inferior route

9 A vertical incision is made in the angle between the xiphisternum and the left costal margin The rectus sheath is incised vertically and the incision deepened in the extra-peritoneal plane through the gap between the xiphoid and costal portions of the diaphragm The pericardial cavity is then opened and drained on its inferior aspect at the most dependent point.

A schematic representation of the inferior approach to the pericardial sac for purposes of open drainage is shown.



POST-OPERATIVE CARE

The intercostal catheter can be removed as soon as the lungs are fully expanded, usually within 24 hours of operation. The myocardium is in a state of disuse atrophy as a result of the prolonged restriction of its activity and acute cardiac dilatation may occur after operation. Oxygen therapy may be indicated, and good nursing can spare the patient any undue exertion likely to aggravate the cardiac dilatation. Digitalis is indicated if excessive tachycardia or auricular fibrillation supervene. Breathing exercises should be resumed as soon as the patient regains consciousness. Post-operative administration of morphine is avoided if possible, and replaced by other analgesics.

Aspiration of the serous cavities may have to be repeated once or twice after the operation, but once the myocardium has regained its tone the effusions rapidly disappear Assuming that histological examination of the resected pericardium reveals no evidence of active tuberculous infection, the rehabilitation of the patient can proceed rapidly

[The illustrations for this Chapter on Pericardiectomy and Drainage of the Pericardium were drawn by Mr J Whieldon]

Bibliography

Churchill, E. D (1936) *Ann Surg* 104, 516
Hewett G J., and Stewart, H. J (1939) *Surg Gynec Obstet.*, 68, 979
Sellors, T Holmes (1946) "Constrictive Pericarditis." *Brit. J Surg.*, 33, 215
Stewart, H. J., and Bailey R. L. (1941). *Amer Heart J.*, 22, 169

PERSISTENT DUCTUS ARTERIOSUS

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PRE-OPERATIVE

Indications

Since many patients with this abnormality die before the age of 40 years from heart failure or infective arteritis, its closure is advised in most instances, preferably between the ages of 4 and 7 years. Operation may be advised in infancy if the lesion is an isolated one and is causing signs of heart failure it is doubtful if surgery should be employed when right ventricular hypertrophy the result of the associated pulmonary hypertension, has caused a reversal of blood flow from the pulmonary artery to the aorta. The diagnosis is made easily when the classical murmur is present. Where the murmur is systolic only special investigations by means of cardiac catheterization may be necessary The operative mortality rate is under 1 per cent in children but is higher in older subjects when cardiac enlargement has become gross.

Pre-operative preparations

A reasonable time should be spent in preparing the patient for operation although in the typical uninfected case this need only be a matter of 2–3 days. During this time, breathing exercises are taught and the patient acclimatized to the routine of the ward. The routine haematological investigations are done. Penicillin is commenced 24 hours before operation. If however the ductus is infected, prolonged chemotherapy is necessary before surgery is carried out. If signs of heart failure exist, digitalis and diuretics accompany the usual medical treatment of that condition.

Anaesthesia

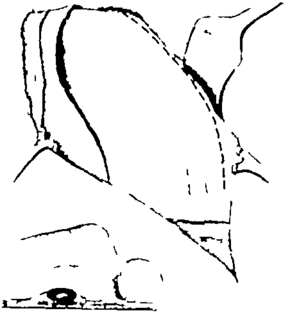
Controlled respiration through an intratracheal tube is essential Pentothal, a muscle relaxant such as curare or Flaxedil, with gas and oxygen are the agents used. Ether has the disadvantage of not allowing diathermy to the wound cyclopropane is contra-indicated because it may cause cardiac irritability Although blood transfusion will rarely be required, an intravenous drip is set up so that blood can be administered in the case of accidental bleeding

Position

The classical thoracotomy position is used with the left side uppermost a small half-moon-shaped rubber cushion is placed under the patient well up to the axilla, so that the uppermost rib spaces are opened out. The position is maintained by a pelvic and chest support, as for other thoracic surgery (Illustration 1)

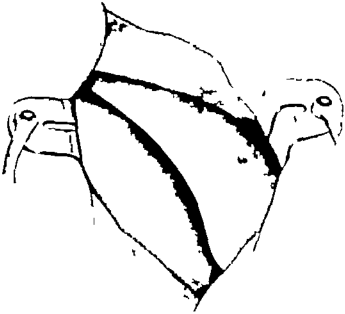
The towels are arranged so that the chest wall is exposed to allow an incision to be made from the edge of the erector spinae along the line of the fourth interspace (Illustration 1)

THE OPERATION



The incision

1 An incision is made from the edge of the erector spinae well forward to end near the costal cartilage. In young girls this incision should slope well below the breast area. The trapezius muscle, part of the rhomboids and of the latissimus dorsi are divided with the diathermy knife. The scapula is then retracted upwards to expose the fourth left interspace which is opened for the full length of the wound some surgeons prefer to resect a rib but *this is unnecessary and undesirable as chest* wall function is better if no rib is sacrificed. In adults, however a full exposure may require a rib resection.

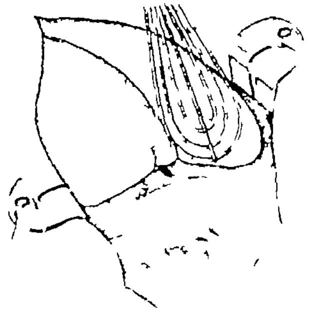


Exposure of the lung

2 After moist saline pads have been placed over each rib a rib-spreader is used to open up the thoracotomy wound to a wide extent.

Exposure of the aorta

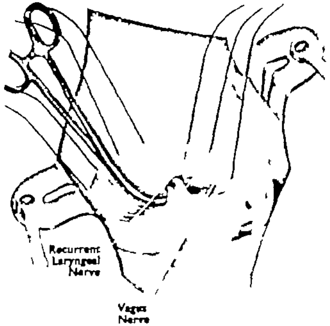
3 The lung, which is kept well inflated throughout the operation is retracted laterally so that descending aorta covered by mediastinal pleura is fully exposed. In the region of the ductus a thrill can be felt where blood is being ejected *into the pulmonary artery* The *mediastinal* pleura is incised along the descending aorta up to the origin of the left subclavian artery (*see* dotted line) This method allows of a far easier quicker and safer approach to the ductus than the one frequently advised, which calls for dissection between the left phrenic nerve and the left vagus nerve

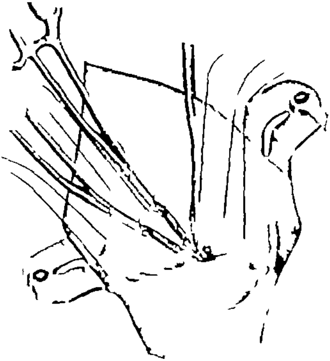


Exposure of the recurrent laryngeal nerve and freeing of the ductus

4 The medial flap of the mediastinal pleura is raised up by a series of fine silk sutures used as retractors. When sufficient sutures have been placed, a moist pad is placed over the lung which is then kept away from the operation field by gentle traction on the sutures

As the mediastinal pleural flap is raised, the vagus nerve and its recurrent branch, which runs round the ductus, can be seen with great clarity the loose tissue around the ductus can be cleared easily and a full exposure of this structure made No blind dissection should be attempted at any stage a curved artery clamp is then passed round the ductus.

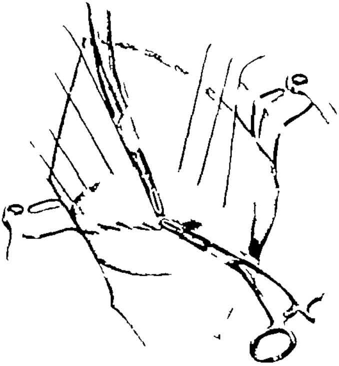




5 Clamping and division of the ductus

Some surgeons are content with simple ligation of the ductus this method though effective in most cases, is unsurgical and carries a risk of recanalization occurring later if it is used the clamp beneath the ductus is opened and one or two stout thread ligatures are drawn back and tied.

Division of the ductus which the writer always advocates and practises, is safely carried out between two Potts teethed clamps. When the ductus is being divided, extreme care is necessary to leave a sufficient fringe on each end of the ductus to allow of easy suturing

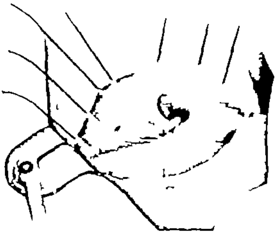


6 Preparing the divided ends for suture

When the ductus has been cut across, the exposure is at once amplified the clamp and the divided ends are firmly held, each by a separate assistant.

The suturing of the divided ends

7 A continuous simple running suture with 00000 silk on an eyeless arterial needle is needed to close the pulmonary end first when this has been completed, the clamp is taken off and gentle pressure with a small pledget mop is kept on the suture line for 5 minutes. Bleeding from the suture line on the pulmonary artery is exceptional should it occur additional interrupted sutures may need to be placed. The closure of the aortic end is then achieved in the same way here some bleeding from the suture line is not infrequent but responds to steady gentle pressure if bleeding still persists after 5 minutes of pressure the aorta above and below the ductus may be clamped and further suturing carried out the clamp should not be in place for more than 10 minutes, as risk to the spinal cord blood supply exists. Another method is to place a Potts clamp as used for aortic pulmonary anastomosis which occludes the ductal opening but allows the blood to flow through the main aortic channel.



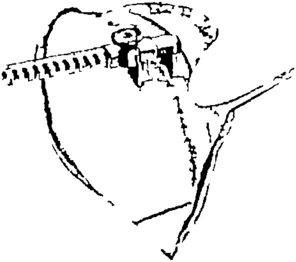
Closure

Repositioning of mediastinal flap

8 The mediastinal flap is sutured back in position. This step prevents the risk of lung tissue becoming adherent to either end of the ductus.

Rib approximation

9 The ribs are then approximated by Holmes Sellors approximator The intercostal space is sutured by interrupted silk sutures (1/10 size) The remainder of the closure is that for any thoracotomy wound, two layers of muscle being sutured together by interrupted silk sutures with the usual skin closure Some surgeons employ an intercostal drainage to a water-sealed bottle as a routine



SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

The patient should have regained light consciousness before return to the ward pain will be relieved by morphine in older patients but children up to the age of 10 years should have papaveretum in doses of $\frac{1}{12}$ gr per year of age. If the thoracic cavity has been drained, the usual attention to the correct management of a water-sealed drain is required. Whether drainage has been employed or not, a radiograph is taken by a portable x-ray apparatus 6–12 hours after operation to enable detection of inadequate lung re-expansion to be made. This inadequate expansion may be due to a pneumothorax or to collapse of the lung, due to the retention of mucous secretions. If the pneumothorax is only a shallow one no further measures need be taken as absorption of the air and re-expansion of the lung will take place If, however the pneumothorax is a considerable one causing displacement of the mediastinum, air should be taken off by means of an artificial pneumothorax apparatus. Collapse of the whole lung or a lobe will usually respond to adequate physiotherapy in which frequent changes of position and assisted coughing play important parts. If in spite of good physiotherapy the lung or lobe fails to expand, bronchoscopic aspiration of the muco-purulent bronchial contents will usually produce prompt re-expansion

Because of the occasional development of infections following suture of any large vessel or of the heart, producing local abscess formation with fatal disruption penicillin should be given for longer periods than is usual and many surgeons now give it for 21 days.

The use of blood transfusion or of oxygen therapy will only be required under exceptional circumstances if operative difficulties have been notable.

Laryngeal stridor

This exceptional complication may occur in young children it is due to bruising of the left recurrent laryngeal nerve or oedema of the cords, caused by the use of too big an intratracheal tube it calls for extreme vigilance, the use of moist air and oxygen. Tracheotomy would be indicated if the symptoms cause any threat to life

Physiotherapy

From the day after operation, chest wall and arm movements are under physiotherapist control. Early ambulation is possible in most instances but should be employed with caution until the tenth day

[The Illustrations for this Chapter on Persistent Ductus Arteriosus were drawn by Miss K. Joy Graham]

Bibliography

Gross, R. E. (1947). "Complete Division for Patent Ductus Arteriosus." *J. Thorac Surg.*, **16**, 314.

— and Hubbard, J. P. (1939) "Surgical Ligation of Patent Ductus Arteriosus report of first successful case." *J. Amer. Med. Ass.*, **112**, 729

CONGENITAL ABNORMALITIES
TETRALOGY OF FALLOT

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PRE-OPERATIVE

BLALOCK S OPERATION

Congenital pulmonary stenosis includes a number of conditions in which the tetralogy of Fallot is most common the clinical features of this are marked loss of exercise capacity and cyanosis. Other conditions such as truncus arteriosus and tricuspid atresia produce the same effects the individual patient may show gross variations in the symptomatology The aim of the Blalock operation is to short-circuit a proportion of systemic blood flow into the pulmonary arteries and through this artificial ductus to increase the oxygenation of blood.

Assessment

Angiocardiography and cardiac catheterization are often necessary to establish the diagnosis and to ensure that an artificial anastomosis will be the correct procedure. In blue babies these procedures are not without risk and are usually performed under general anaesthesia. Complete clinical and radiological investigation is also necessary this usually being carried out in a special cardiological unit.

Pre-operative preparation

A period of bed-rest may improve the patient s general condition and to prevent the risk of thrombosis large quantities of fluid are given. The patient is also accustomed to the oxygen apparatus which is used after the operation, and pre-operative physiotherapy and breathing exercises are given as a routine.

Anaesthesia

A preliminary small injection of Pentothal and curare is given to allow an endotracheal tube to be passed and through this 50 per cent oxygen and 50 per cent nitrous oxide are administered occasionally small additional doses of basal anaesthetics are used during the operation these are given through an intravenous drip which can be also used for blood transfusion.

Position of patient

The operation can be performed on either side more usually on the left (the original Blalock operation was right sided) The patient is placed in the lateral position the left side uppermost, supported by a small chest rest and sand bags. If a lateral inclination is to be used the patient should be held on the table with webbing straps.

POTTS OPERATION

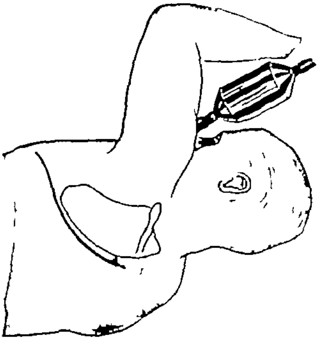
The indications for Potts operation are the same as those for Blalock s, the principle of both being identical—the anastomosis of a systemic with a pulmonary vessel. Potts operation is preferred by some surgeons for technical reasons, but can only be performed on the left side, and if there is any technical complication during the anastomosis there may be considerable danger as the aorta is involved.

THE OPERATIONS

BLALOCK S OPERATION

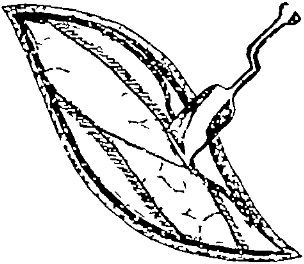
The incision

1 The incision starts close to the spine and is carried forwards round the angle of the scapula towards the anterior axillary line where it terminates just below the nipple In very cyanotic patients blood oozes and is dark. The incision is deepened dividing posteriorly the lower part of the trapezius muscle, the full width of the latissimus dorsi and part of the serratus magnus to expose the ribs.



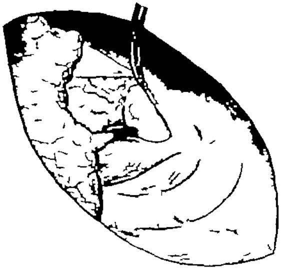
Opening of pleural cavity

2 The scapula, now partly free from muscle attachments, is raised in a retractor and the periosteum is then stripped from the rib and the bone divided at the front and back ends of the incision. The pleura is divided through the bed of the rib and the incision opened by use of a powerful rib-spreader



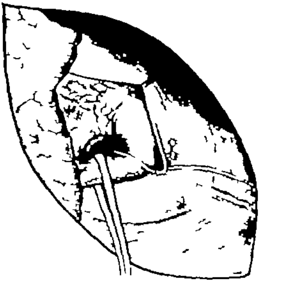
Division of pericardium

3 The lung is allowed to collapse and any intrapleural adhesions are divided. The lung is held down and back to expose the pericardium and region of the lung root. The pericardium is then incised parallel to and just posterior to the phrenic nerve. The pulmonary artery and the infundibulum are palpated and if required pressure readings are taken from the pulmonary artery and right ventricle in order to assess the site of the stenosis.



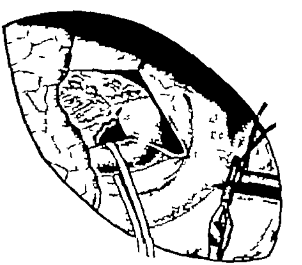
Exposure of pulmonary artery

4 The left pulmonary artery is identified within the pericardium and following the division of a number of tortuous bronchial and systemic arteries the extrapericardial portion of the left pulmonary trunk is exposed. Careful dissection within the adventitia improves the exposure of this vessel until a length of $\frac{3}{4}$–1 inch is exposed on all surfaces.



Isolation and division of subclavian artery

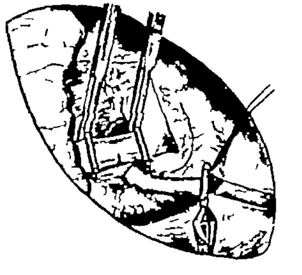
5 The left subclavian artery is identified as it rises from the aorta and, following division of the mediastinal pleura, is isolated. Dissection is carried out until a sufficient length is obtained to reach, when divided, the pulmonary artery. This may involve division between ligatures of the internal mammary, vertebral, superior intercostal and thyrocervical arteries: these are all fragile and can be easily torn. A ligature is placed as high as possible and a clamp applied at the base of the artery before division. Having divided the artery the adventitia is carefully and meticulously removed to facilitate the anastomosis.



Approximation of arteries

6 The left pulmonary artery is now held proximally in a Blalock clamp, the distal end being secured by check ligature or second clamp. The divided subclavian artery is turned down over the arch of the aorta to lie close to the pulmonary artery. A 3–4 mm. opening is then made transversely in the superior part of the pulmonary artery.

The two vessels are then ready for anastomosis. The suture to be used consists of 00000 silk or plastic on the smallest possible eyeless needle. The slightest uncontrolled pull or roughness may break the stitch or tear the edges of the vessels.

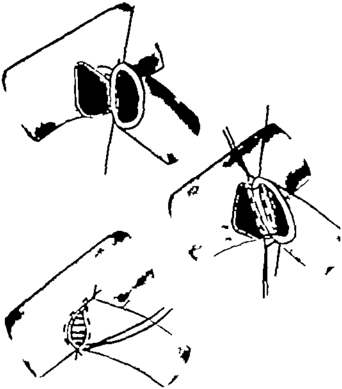


Arterial anastomosis

7 The suture used is of the everting mattress type starting on the posterior layer The sequence of the needle point entry is as follows

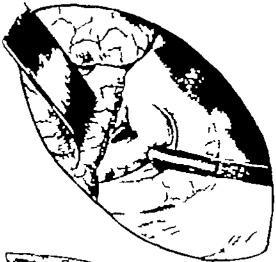
Outside of the subclavian artery inside the pulmonary outside the pulmonary inside the subclavian outside the subclavian and so on for 4 or 5 sequences. The stitches should be 1 mm deep and 1 mm apart. The back row is drawn taut and tied to a stay suture inserted at each end. The stay sutures are continued round each side to complete the anastomosis. Occasionally additional interrupted sutures are required.

The clamp on the distal pulmonary artery is released and blood swells the junction. Then the control clamp on the pulmonary artery is slackened and if there is no excess of blood leak, the clamp on the subclavian artery is removed. The distended vessel tightens up the suture line



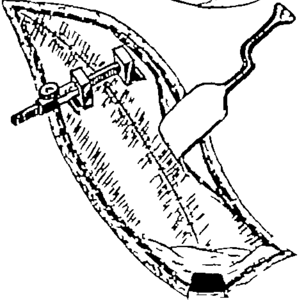
Examination for leakage

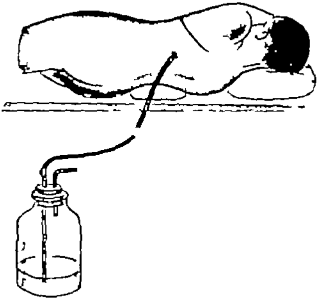
8 After the junction has been completed and is seen to be blood-tight" the lung is inflated by the anaesthetist and the operation area checked for bleeding points. A low posterior drainage tube is inserted through an intercostal space and connected to a water-seal.



Wound closure

9 The wound is closed first by a catgut suture between the divided intercostal muscles, the tension being relieved by an approximator or retractors. The muscles are sutured in 2 layers.



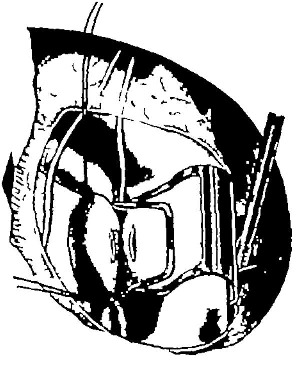


Drainage

10 A subcutaneous suture is used before the skin edges are brought together The water-seal drainage system is checked to see that there is no obstruction.

POTTS OPERATION

The incision is the same as for Blalock's operation. The chest having been opened through the fourth intercostal space the lung is allowed to collapse and is retracted. The pulmonary artery is identified and exposed as described for Blalock's operation, and the pleura over the distal part of the aortic arch is incised. The superficial aspect of the arch of the aorta is easily freed, but the upper one or two intercostal arteries may have to be divided between ligatures this must be done with great care in small children. Should an intercostal artery tear from the parent stem the opening must be secured by a stitch. On the deeper aspects one or two right intercostal arteries will have to be divided and possibly a bronchial vessel as well. At least two inches of aorta should be freed and this section lifted from its bed on a tape.



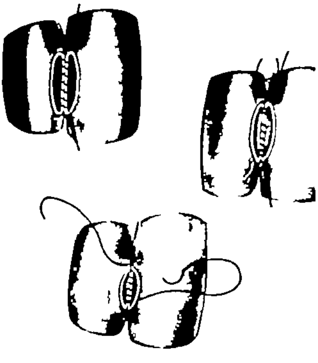
Application of Potts' clamp

11 The use of a special clamp designed by Potts allows a section of the aorta to be "pinched out" in the blades of the clamp while still allowing a portion of the aortic stream to flow uninterruptedly

A Potts clamp is placed on the aorta in such a way that a loop of the vessel protrudes from the clamp and within the bite of the clamp there is still a small tip of aorta through which blood passes. The left pulmonary artery held proximally and distally in loop ligatures, is then brought up to the clamp and the ligatures are passed through the protruding eyes at each end of the clamp the two vessels thus lie side by side

Arterial anastomosis

12 After having removed the more obvious strands of adventitia an incision 7–8 mm. long is made with a knife in each vessel A 00000 suture is applied to the deep layer and after the manner of a Blalock operation is drawn tight and secured by a stay-suture at each end. The free ends of the stay-suture are used for the front layer with an everting stitch which is tied over the mid-point. The pulmonary artery is released distally and then, if there is little or no bleeding centrally and finally the Potts clamp is slackened. Withdrawal of the clamp is not always easy because the under blade lies deeply in the mediastinum. The completed anastomosis should not be more than 4 mm. in diameter The chest is closed with temporary water-seal drainage as described for Blalock s operation.



POST-OPERATIVE CARE AND COMPLICATIONS

BLALOCK S OPERATION

The patient is placed in an oxygen tent for the first 12 or 24 hours and the water-seal drain carefully to see that there is no undue loss of blood. The chest is radiographed 24 hours after the operation and ı lung is fully expanded and there is no excess drainage the water-seal tube is removed and the wound sealed

Haemorrhage, thrombosis

Haemorrhage may occur from leakage at the junction or from a bronchial vessel which was not adequate secured. The high packed-cell volume of these polycythaemic patients predisposes towards thrombosis which, severe cases, occurs in the cerebral vessels leading to coma and occasionally death.

Left arm

The division of the subclavian artery and its branches does not lead to any trouble in young children the hand is frequently cold for some days. In older patients, particularly if there has been any collapse, muscl ischaemia with a subsequent Volkmann type of contracture may occur A brachial plexus block and injection papaverine into the brachial artery is of help if this complication is suspected.

POTTS OPERATION

The post-operative care and complications are the same as for Blalock s operation If too wide an anastomo is made the left-to-right vascular shunt leads to considerable enlargement of the left ventricle and ultimately heart failure.

[*The illustrations for this Chapter on Tetralogy of Fallot were drawn by Mr J Wheldon*]

Bibliography

Blalock, A., and Taussig, H. B (1945) *J Amer med. Ass.*, **128**, 189
Campbell, M., and Deuchar D (1953). *Brit. med J* 349
Potts, W J Smith, S., and Gibson, S (1946). *J Amer med. Ass.*, **132**, 627
Taussig, H. B., and Bauersfeld, S. R. (1953). *Ann. Int. Med.*, **38**, 1

CONGENITAL ABNORMALITIES
ATRIAL SEPTAL DEFECTS
OPEN AND CLOSED METHODS

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PRE-OPERATIVE

Indications

The presence of an atrial septal defect of ostium secundum type with a significant left to right shunt is an indication for operative repair A minority of cases will have a negligible shunt and can possibly be kept under observation. It is wrong to wait for the development of symptoms before advising operation as there may then be irreversible changes, particularly in the pulmonary vascular bed.

Contra-indications

The development of increased pulmonary vascular resistance with reversal of the shunt contra-indicates closure of the defect. Also ostium primum defects, where diagnosed pre-operatively are only able to be closed with safety by present techniques with the aid of the heart lung by-pass.

Pre-operative preparation

Cardiac catheterization is an essential pre-operative investigation to estimate the volume of the shunt, the pulmonary resistance and the presence of partial or total anomalous pulmonary venous drainage. A number of blood samples should be taken from the right atrium and vena cavae to avoid errors of sampling as a result of incomplete blood mixing at the level of the shunt

Anaesthesia

Hypothermia is required in the open method of repair Conventional thoracic anaesthesia is used with the addition of enough relaxant to prevent shivering Cooling of the tissues is brought about by immersion of the body in cold water (Swan, 1954) or by pumping the venous blood through a cooling coil after exposure of the heart (Brock and Ross, 1955) The body temperature is reduced to 28° C which allows 8–10 minutes of arrested circulation

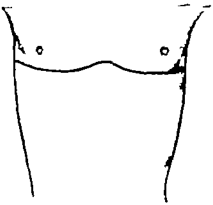
Position of the patient

The patient lies supine with the arms abducted to allow access to the axillae the surgeon stands on the patient s right side

Electrocardiograph leads and temperature recording apparatus are connected before towelling

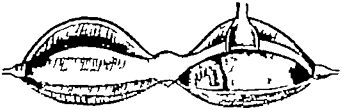
THE OPERATION

OPEN METHOD



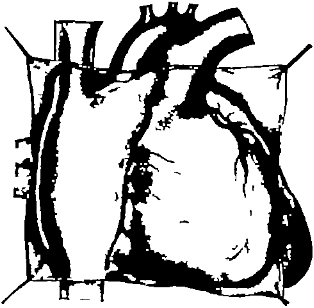
The skin incision

1 A bilateral submammary skin incision is used and extended laterally to the anterior axillary lines.



Exposure of the heart

2 The pectoral muscles are divided in the line of the fourth ribs and the serratus anterior muscles are split along the line of these ribs The internal mammary arteries are ligated and a V division of the sternum is made with a Gigli saw or stout scalpel. Incision of the periosteum in the bed of the fourth ribs and retraction of the sternal edges gives a wide exposure of the heart



External inspection of the heart

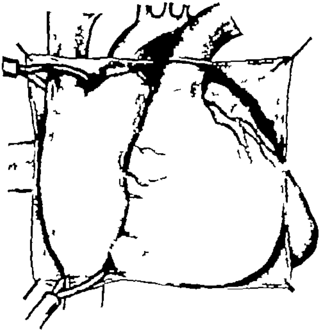
3 A cruciate incision is made in the pericardium and the flaps are turned back. An external inspection of the heart and vessels is then carried out in a typical case of atrial septal defect there is considerable enlargement of the right atrium right ventricle and pulmonary artery while the left ventricle and aorta are small. The vena cavae are also generally of small diameter and like the aorta, reflect the small systemic flow An external inspection is also made at this stage for anomalous pulmonary veins draining into the right atrium or vena cavae

Digital exploration of the interior of the right atrium

4 A purse-string suture is inserted in the tip of the right atrial appendage and a small incision is made to permit the entry of the right index finger. The size and position of the defect are noted and the orifices of the mitral and tricuspid valves are explored for stenosis or regurgitation. A search is again made for anomalous pulmonary venous drainage. (When venous blood-stream cooling is employed, catheters are inserted into the venae cavae through this incision in the atrium.)

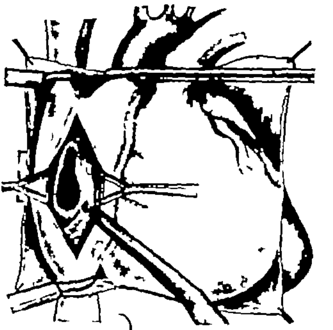
Snaring of the great veins

5 The superior and inferior venae cavae are mobilized intrapericardially by incising their parietal pericardial sheaths. Soft rubber catheters are then passed around these vessels to act as snares.



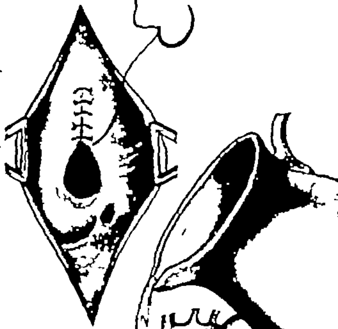
Arrest of the circulation and atrial cardiotomy

6 The vena caval snares are tightened and, after a few beats to allow the heart to expel its blood, a clamp is placed across the aorta and pulmonary artery through the transverse sinus. A 4–5 cm. incision is made in the atrial wall with scissors and the edges are held apart with Duval's forceps. A dry field is secured and maintained with the sucker by aspirating the small coronary venous return The sucker tip must not be passed through the defect in order to prevent the entry of air into the left atrium



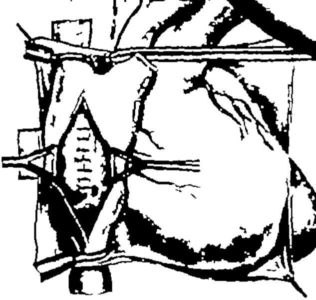
Closure of the defect

7 The defect is closed with a running suture of 2/0 silk on an atraumatic needle and is generally reinforced with one or two additional interrupted sutures. Great care must be exercised inferiorly to avoid incorporating the valve of the inferior vena cava. Anomalous pulmonary veins adjacent to the margins of the defect are incorporated in the left atrium by bringing the septum down to the right atrial wall on the near side of their orifices.



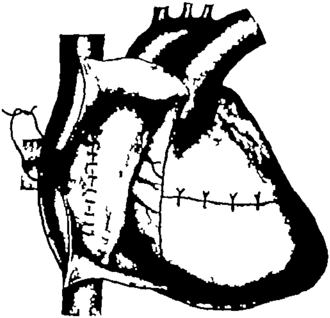
Re-establishment of the circulation

8 The right atrium is flooded with saline to exclude air and the atrial incision is temporarily clamped in order to re-establish the circulation without delay



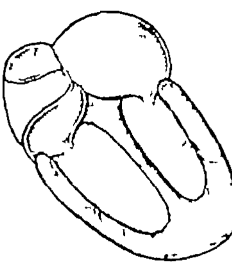
Closure of the cardiotomy, pericardium and chest

9 After release of the vena cavae and clamp across the transverse sinus the atrial incision is closed with a continuous suture. The pericardium is closed with interrupted sutures and the pleural cavities are drained separately. The sternum is drilled and the cut edges are brought together with a wire or nylon stitch.



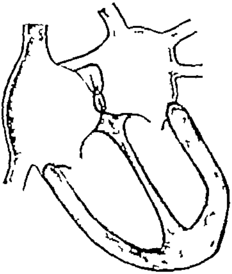
CLOSED METHODS

A closed repair of the defect can be achieved through a transverse thoracotomy as described above or through a standard antero-lateral thoracotomy. The size and position of the defect and the presence of associated anomalies are decided by a preliminary digital exploration of the right atrium after which the defect can be closed by one of three methods. (Details of these methods should be obtained from original articles, *see* Bibliography.)



Bailey's technique of atrio-septo-pexy

10 This technique involves sewing down the redundant right atrial wall to the rim of the defect while the left index finger guides the sutures into position.

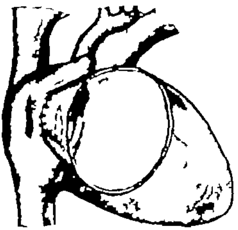


Sondergaard's method

11 This method necessitates a preliminary dissection of the groove between the right and left atria after which a circumferential suture is passed around the defect with a blunt needle and tightened until the defect is felt to close.

Gross's method

12 A semi-closed method has been devised by Gross. The right atrium is opened in the floor of an attached rubber well and blood is allowed to rise in this to a level corresponding with the right atrial pressure. The defect is then repaired by direct suture under the surface of the blood



POST-OPERATIVE CARE

Blood replacement

Blood freshly drawn on the day of operation is given during rewarming to reduce the tendency to post-operative oozing in hypothermic cases. One should aim to undertransfuse because of the possibility of cerebral oedema as a reaction to the period of circulatory arrest and to allow the underdeveloped left side of the heart to accommodate to an increased load after closure of the shunt. Pulmonary oedema is easily precipitated by over-enthusiastic blood replacement post-operatively and during the first few weeks.

Temperature recording

Where hypothermia has been used, body temperature should be charted at frequent intervals during the first 24 hours. A steady rise may be evidence of cerebral damage and an indication to limit fluids.

Drainage tubes

A tube is inserted in each pleural cavity at operation and these must be connected to separate underwater seals. A considerable volume of blood can pool posteriorly when the patient lies supine so that he should be sat up at regular intervals to drain any accumulations into the bottles. Both tubes can generally be removed within 24 hours and the patient can get out of bed on the second or third post-operative day depending on the general condition.

[The illustrations for this Chapter on Atrial Septal Defects were drawn by Mr J Wheldon]

Bibliography

Bailey C. P., Bolton, H. E., Jamison, W L., and Neptune, W B (1958). "Atrio-septo-pexy for Interatrial Septal Defects." *J thorac Surg.*, 36, 184.

Brock, R. C., and Ross, D N (1956). "Hypothermia. (8)—The Clinical Application of Hypothermic Technique " *Guy's Hosp Rep* 104, 99

Gross, E. E., Watkins, E., Pomeranz, A. B., and Goldsmith, E. I. (1953). "A Method for Surgical Closure of Interatrial Septal Defects." *Surg Gynec Obstet.*, 96, 1

Lewis, J F., Taufic, M., Varco, R. L., and Niazi, S (1955) "The Surgical Anatomy of Atrial Septal Defects." *Ann. Surg.*, 142, 401

Søndergaard, T (1954). "Three Operated Cases of Atrial Septal Defect." *Acta. chir Scand.*, 107 492.

Swan, H and Zeavin, I. (1954) "Cessation of Circulation in General Hypothermia (3) " *Ann. Surg.*, 139 385

CONGENITAL ABNORMALITIES

COARCTATION OF THE AORTA

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PRE-OPERATIVE

Indications

Coarctation of the aorta is rare except in close relation to the attachment of the ligamentum arteriosum or ductu arteriosus Most cases are asymptomatic and a sound prognosis in the individual case usually cannot be made. The indications for a surgical attempt to overcome the aortic obstruction are based on the frequency of death before the age of 40 from some complication of arterial hypertension such as intracranial haemorrhage, heart failure or aortic rupture Resection of the coarcted segment of the aorta with end-to-end anastomosis providing a lumen of approximately normal size is the operation of choice Patients between the ages of 8 and 25 years found to have coarctation of the aorta severe enough to cause hypertension in the upper limbs or delay or weakness of the femoral pulse should have the coarctation resected. The operation is best performed about the age of 8 years, when the aorta has the elasticity of childhood and yet has a large lumen. Above the age of 25 and below the age of 8 operation may be necessary for the relief of symptoms, or because of increasing left ventricular hypertrophy or because of the development of an aneurysm above or below the coarctation. The operation has been performed in infancy for heart failure not fully responding to medical treatment.

Contra-indications

There is nothing to be gained from resection of the coarctation when there is an associated anomaly with a worse prognosis. A congenital lesion of the aortic valve with stenosis or incompetence is not necessarily a contra-indication

Special equipment

Clamps, such as those designed by Potts or by Crafoord, are required for aortic occlusion.

Except when it has been shown by aortography that the coarctation is short, a preserved homologous graft of suitable size should be available.

In all cases blood should be ready for transfusion.

Anaesthesia

General anaesthesia with tracheal intubation and controlled respiration is satisfactory Manipulation of the aorta and its branches is made easier especially in adults, if hypotension is induced by a ganglion-blocking drug such as a hexamethonium salt or a thiophanium derivative (Arfonad)

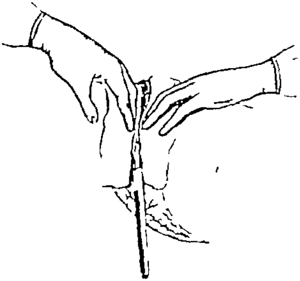
Position of patient

The right lateral position, as for left thoracotomy is satisfactory

THE OPERATION

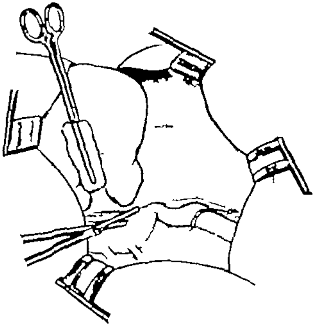
Thoracotomy

1 A long left lateral thoracotomy is made (see Surgical Access to the Chest, Part V page 86) Although the arteries of the parietal muscles are abnormally large, this can be done with little blood-loss if the muscles are divided a short segment at a time with firm digital pressure on each side of the incision until the vessels are secured. The fifth rib is resected from the tip of the transverse process to the costochondral junction and the pleural space is opened through its bed.



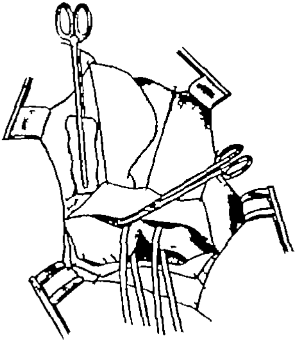
Exposure of the aorta

2 The wound is opened to its full extent. After general inspection of the lung and mediastinum, the lung is displaced downwards and forwards to expose the left subclavian artery the coarctation and the post-stenotic dilatation of the descending aorta. The left superior intercostal vein is divided as it passes across the aortic arch near the origin of the left subclavian artery to enter the left innominate vein. The mediastinal pleura and aortic sheath are incised from the level of the left main bronchus proximally and the incision is continued for 3 cm. on the left subclavian artery



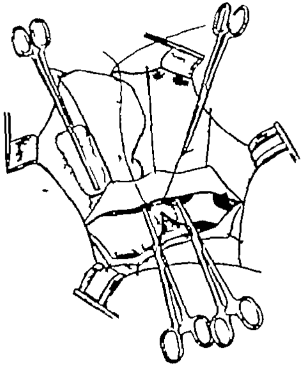
Mobilization of the aorta

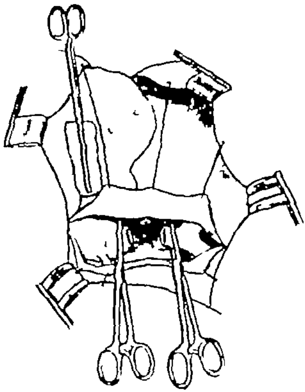
3 The aortic sheath is reflected and fixed by sutures to the wound towels. In addition to giving a constant exposure, this helps in the retraction of the lung and displaces the vagus nerve and its recurrent branch from the area of operation. It is desirable to mobilize the coarcted segment and at least 2 cm. of the aorta above and below it. This usually requires division of one or more intercostal or bronchial arteries. These fragile arteries mostly arise from the aorta beyond the coarctation, but may arise proximally. The arterial sheath is opened and fine silk ligatures are placed before division of the artery. The recognition and ligation of the right intercostal arteries are aided by light traction on tapes placed round the aorta close to the coarctation.



Occlusion of the aorta

4 The ductus arteriosus or ligamentum arteriosum is freed and, unless it clearly has no lumen, is controlled at its pulmonary end with a suture-ligature. The extent of coarcted aorta which must be excised in order to leave a channel equal to that of the aorta at the origin of the subclavian artery is estimated. Clamps are applied 0.75 cm. from the proposed lines of section, their handles lying in the posterior end of the parietal incision. When the segment of aorta between the subclavian artery and the coarctation is very short, it may be necessary to place one clamp across the aortic arch distal to the left common carotid artery and a second across the left subclavian artery.

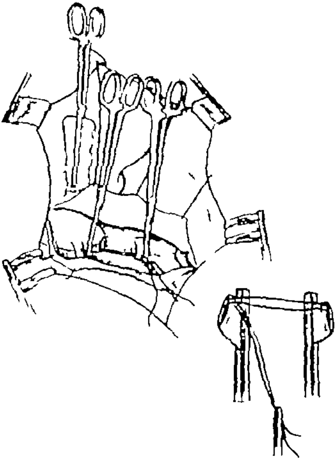




Excision of the coarctation

5 The aorta is divided at the upper and lower limits of the coarctation each division being made with a single cut. Elastic retraction of the divided aorta widens the gap but it is usually easily possible to approximate the cut ends.

Rarely the excised segment is so long that the gap cannot be closed in this way Either a preserved aortic graft is used to bridge the gap (see Arterial Grafting Part VII Volume 4) or after closure of the proximal aortic end by suture the left subclavian artery which may have a lumen almost as large as that of the aorta, is divided at the origin of the vertebral artery turned downwards, and anastomosed end-to-end to the descending aorta.

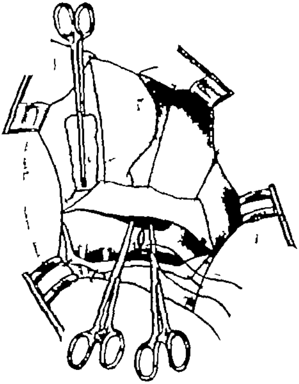


The anastomosis

6 The anastomosis is made with a single row of interrupted mattress sutures of 00000 silk, the loop of each suture lying on the outer surface of the aorta. The posterior sutures are introduced first, beginning with the suture farthest from the operator The posterior aortic wall is best exposed by rotation of the clamps so that the handles lie anteriorly If this cannot easily be done the clamps are rotated on their long axis through 90 degrees (*inset*) In this position the sutures are introduced but not tied until all the posterior sutures have been placed. Strain on the suture line while it is still incomplete is prevented by constant approximation of the clamps.

Removal of the clamps

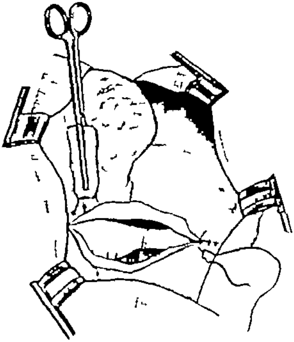
7 The clamps are returned to their original position and the anterior sutures are completed. The distal clamp is loosened. If there is free bleeding from a gap in the suture line, the distal clamp is re-applied and an additional suture is introduced If there is little bleeding both clamps are removed, the proximal one gradually and digital pressure is applied to the anastomosis until bleeding has ceased. Removal of the clamps may be followed by an immediate and excessive drop in blood pressure transfusion of whole blood plus temporary partial digital occlusion of the aorta will return this to a higher level.



Closure

8 The mediastinal pleura and aortic sheath are repaired with interrupted fine silk sutures. A low intercostal drain is introduced and attached to a water-seal.

Particular care is taken in the final inspection of the wound to ensure haemostasis. The systemic blood pressure, which is commonly low at this stage, may rise even above its pre-operative level after recovery from anaesthesia and cause bleeding from the very large parietal vessels. The chest wall is closed in layers.



POST-OPERATIVE CARE AND COMPLICATIONS

The drainage tube is removed after 24 hours. In a few cases, after removal of the tube blood-stained effusion re-accumulates in the left pleural space and should be aspirated There is a theoretical danger from puncture of a large vessel during thoracentesis.

The patient should remain in bed for two weeks and avoid strenuous effort for three months.

Post-operative complications are infrequent.

Persistent hypertension

Reduction of the arterial pressure in the upper part of the body to a normal level, which is usually the main object of operation may be delayed for two to three weeks Rarely the pressure, although lowered may never fall to a normal level. The older the patient, the more likely is this failure of adjustment of the pressure. Provided that an anastomosis of good size has been made immediately after the operation the pulses in the lower limbs become palpable with normal ease and the femoral arterial pressure becomes greater than the brachial.

Aneurysm

A false aneurysm may occur at a point of leakage from the suture line (Gross, 1950) It calls for a re-exposure of the aorta, control of its lumen with clamps as for resection, and repair of the defect in its wall.

Haematoma in the chest wall

Bleeding may occur in the chest wall, especially from the vessels in the substance of the latissimus dorsi. Evacuation of a haematoma may be required (Crafoord, Ejrup and Gladnikoff, 1947)

Other complications

Injury of the para-aortic structures is unlikely since they are excluded from the operative field by the aortic sheath, but laryngeal paralysis from interruption of the left vagus nerve or its recurrent laryngeal branch may occur Similarly chylothorax may follow damage to the thoracic duct. Traumatic chylothorax usually responds to repeated pleural aspiration.

[The illustrations for this Chapter on Coarctation of the Aorta were drawn by Miss Una Mackae]

References

Crafoord, C., Ejrup B and Gladnikoff H. (1947) "Coarctation of the Aorta." *Thorax* **2**, 121
Gross, R. E. (1950) "Coarctation of the Aorta—Surgical Treatment of One Hundred Cases." *Circulation* **1**, 41

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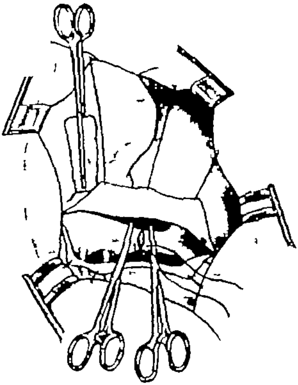

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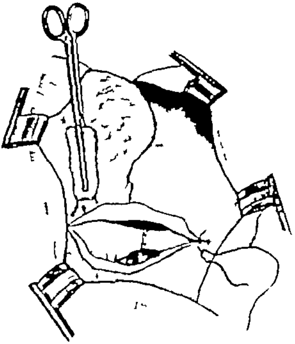

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Bleeding may occur in the chest wall especially from the vessels in the substance of the latissimus dorsi. Evacuation of a haematoma may be required (Crafoord, Ejrup and Gladnikoff, 1947)

Other complications

Injury of the para-aortic structures is unlikely since they are excluded from the operative field by the aortic sheath, but laryngeal paralysis from interruption of the left vagus nerve or its recurrent laryngeal branch may occur Similarly chylothorax may follow damage to the thoracic duct. Traumatic chylothorax usually responds to repeated pleural aspiration.

[The illustrations for this Chapter on Coarctation of the Aorta were drawn by Miss Una Mackie]

References

Crafoord, C., Ejrup, B., and Gladnikoff, H. (1947). "Coarctation of the Aorta." *Thorax*, 2, 121
Gross, R. E. (1950). "Coarctation of the Aorta—Surgical Treatment of One Hundred Cases." *Circulation*, 1, 41

CONGENITAL ABNORMALITIES
PULMONARY STENOSIS
PULMONARY VALVOTOMY

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PRE-OPERATIVE

In pure pulmonary stenosis or in any form of pulmonary stenosis in which a congenital malformation of the pulmonary valve is the seat of obstruction a direct operation is indicated. This consists of instrumental division and dilatation of the valve blindly through the right ventricle or retrograde through the pulmonary artery

More recently the stenosed pulmonary valve has been divided under direct vision while the circulation is arrested under hypothermia. Hypothermia is induced by surface cooling or a veno-venous method and a bilateral thoracotomy performed In this a transverse incision across the chest is made through the third or fourth intercostal spaces and the sternum is divided The incision is widened and the pericardium freely exposed.

Control tapes are placed round each vena cava and these are tightened to occlude the venous inflow At the same time a clamp is placed across the base of the aorta and the root of the pulmonary artery is opened with a longitudinal incision. Blood is sucked clear and the diaphragm-like pulmonary valve divided with scissors to form a bicuspid valve.

The venae cavae are released and the aortic clamp removed. As blood wells into the incision in the pulmonary artery a lateral clamp is placed so as to secure the wound edges. These are then closed by a simple continuous suture.

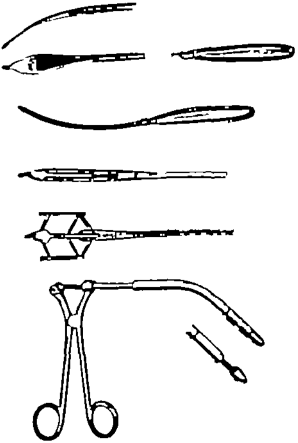
The pericardium is sutured and the chest wall closed. Each pleural cavity is drained with a closed water-seal.

Assessment

The use of cardiac catheter pressure readings in locating the site of stenosis is most important. If there is no communication between the ventricles (as occurs in Fallot's tetralogy) valvotomy is the operation of choice in preference to an anastomotic operation The patients with a pure pulmonary stenosis are often much less disabled than those with Fallot's tetralogy and are not so cyanosed. They frequently have an additional shunt in the form of a patent inter-auricular septum or persistent ductus arteriosus.

Pre-operative preparation and anaesthesia

The preparation is the same as for Blalock's operation (Part V page 182) and the anaesthetic is similar The approach is through the left chest with the incision placed more anteriorly than in the case of the Blalock's and Potts operations.



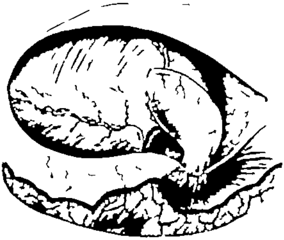
THE OPERATION

Instruments

1 (1) Brock's valvotome.
(2) Exploring sound.
(3) Expanding dilator (Sellors pattern)
(4) Brock's infundibular punch.

The incision

2 With the patient in the lateral position and inclined so that the front of the chest faces more upwards, an incision is made and the chest entered through the fifth intercostal space.



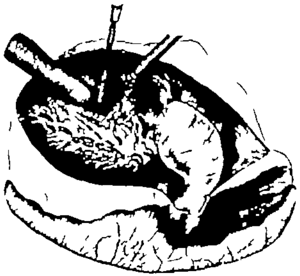
Location of stenosis

3 The lung is retracted and the pericardium inspected. It is then incised anterior to the phrenic nerve for its full length. Traction on the cut edge of the pericardium brings the heart a little more to the left and into view The right ventricle and pulmonary artery are inspected a valvular stenosis is usually palpable as a knuckle thrusting against the finger Pressure readings above and below this point may demonstrate a marked pressure gradient and locate the site of the stenosis.

Ventricular incision

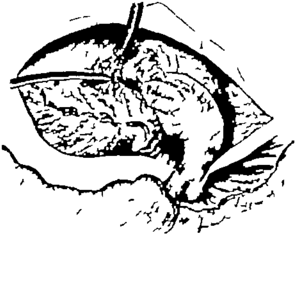
4 A purse-string suture (eyeless 00000 plastic) is placed in the wall of the right ventricle just below the infundibulum The ends of this are passed into a Rumel tourniquet and within this area a small incision is made into the wall of the ventricle. A special probe director or cardiac catheter is passed into the right ventricle and the opening in the valve sought. The tip of the catheter or instrument can be felt in the main pulmonary artery

It is not essential to use a purse-string suture and tourniquet. Bleeding can be controlled by pressure of the finger on the incision while a suture is placed deep to this.



Insertion of valvotome

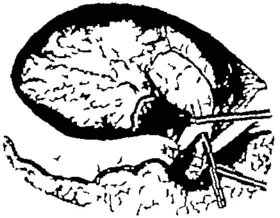
5 The incision is slightly enlarged and an expanding valvotome (Potts or Sellors pattern) or a fixed blade knife (Brock) directed upwards and forced through the valve which is cut in two planes. The instrument is withdrawn and on each occasion the ventricle incision controlled by tightening the tourniquet or pressure of the finger Next a dilator of expanding pattern or solid type is passed through the divided valve to ensure a free passage If the heart has withstood these manipulations satisfactorily and if there is little loss of blood the pressure readings are again taken When instrumentation is complete one or two 000 or 0000 stitches are used to close the incision these are not pulled too tightly The purse-string is then removed and the pericardial flap loosely closed.



Retrograde valvotomy

6 The pulmonary artery is identified and the left branch dissected free towards the lung root. A control ligature is placed distally round the vessel and a loose ligature passed round the vessel close to the main trunk Between these a small incision is made and the valvotome passed downwards and through the valve the fingers can easily palpate and avoid misdirection (which would be disastrous) A valvotome and dilator are passed and when a free passage has been obtained the incision in the pulmonary artery is closed by an everting stitch. The check ligature is tightened round the instrument during the manipulation to avoid loss of blood. The chest is closed and drained as with the former operations.

In certain cases where the stenosis is narrow and located to the infundibulum a punch resection, as practised by Brock (Illustration 1) is of great value. The punch illustrated is used to bite off fragments of the stenotic area until an adequate channel is produced.



POST-OPERATIVE CARE AND COMPLICATIONS

The post-operative treatment follows the same lines as for Blalock s operation, but tachycardia is common obvious improvement delayed.

The use of hypothermia for an open approach to the stenotic area has great possibilities, but the risks of procedure have to be taken into account. Swann has pointed out that the *physiological results of such an* c operation under hypothermia are superior to those of the more 'blind operations described in this chapter

[*The illustrations for this Chapter on Pulmonary Valvotomy were drawn by Mr F Price*]

Bibliography

Brock, R. C. (1948) *Brit. med J.*, 1, 1121
— (1950) *Brit Heart J.*, 12, 403
— and Campbell, M. (1950). *Brit. med J* 1, 1283.
Sellors, T H. (1948). *Lancet*, 1, 988.

MITRAL VALVOTOMY

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PRE-OPERATIVE

Indications

As yet the only well established operation in the treatment of rheumatic heart disease is that of mitral to correct mitral stenosis. Any patient between the ages of 25 and 55 years who has pure mitral steno has a disability sufficient to justify an operative risk of 5 per cent should be considered for valvotom a history of systemic embolism is an indication for valvotomy even in the absence of dyspnoea.

Contra-indications

Predominant mitral incompetence is a contra-indication, and mitral valvotomy alone is of little aortic valve lesions are responsible for the patient's symptoms. Surgery should be avoided as far as those under the age of 25 years as rheumatic fever may recur and it is seldom justified over the age o

Histories of congestive cardiac failure or of previous emboli are by no means contra-indications, nor a fibrillation, pulmonary hypertension, or calcification of the valve.

Pre-operative preparation

If digitalis is already being given, it should be continued up to the time of the operation if not, started a few days before surgery for although the drug does not prevent fibrillation, it does prevent m tachycardia should this complication occur

A low-salt diet should be taken for at least a week prior to the operation, but the patient should not l to bed during this period.

Atropine should be avoided as a premedication, as the cardiac output may be reduced by the tac produces pethidine is preferable. If the patient is orthopnoeic it is essential that he should remain in position while being taken to the theatre.

Position of the patient

The patient lies on his right side on a chest rest, the head and the pelvis are securely anchored to th wide flannel bandages so that he may be rolled slightly backwards when the chest is opened. The left above and in front of the patient's face to draw the scapula up as far as possible.

Anaesthesia

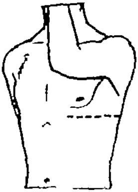
It is essential that a technique should be used which a onsiderable degree of of the l order that it may not be obtrusive during the intracard ulations.

Before commencing the operation an intravenous inf ld be set up and a hould be whereby very rapid transfusion may be given in an eme

THE OPERATION

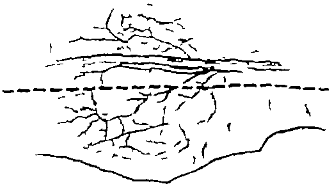
Incision

1 A long postero-lateral incision is made from one inch from the midline posteriorly to the anterior axillary line. The trapezius and the rhomboid muscles are partially divided, and the latissimus dorsi is completely cut the incision is then carried down through the serratus anterior The pleural space is entered through the bed of the fifth rib or through the fifth interspace. The ribs are spread apart and held in that position by a self-retaining retractor



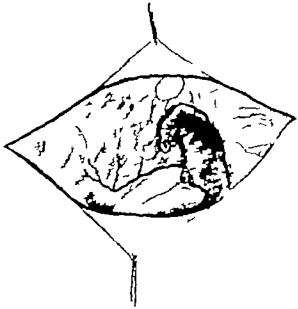
Opening the pericardium

2 The lung is retracted backwards and an incision is made in the pericardium half an inch behind the phrenic nerve and parallel with it. This incision should extend from the upper edge of the pulmonary artery almost to the diaphragm Two long curved forceps are applied to the posterior edge of the incision to act as retractors and to hold the lung out of the way a stitch is passed through the anterior edge and through an adjacent intercostal muscle to hold the pericardium forwards during manipulations.



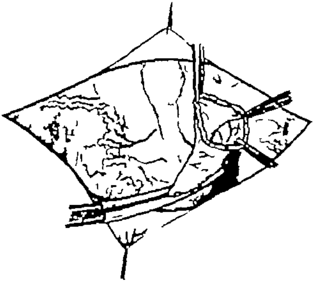
Amputation of the auricular appendage

3 A special non-crushing clamp is applied to the base of the appendage, care being taken not to include the coronary sinus. The tip of the appendage is amputated in such a way that the resulting lumen will just admit the second interphalangeal joint of the index finger



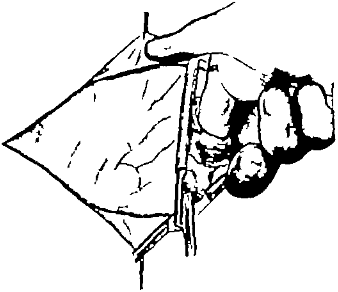
Disposal of thrombi

4 The clamp is momentarily released to allow any loose thrombi to be washed out. The index finger is then insinuated through the appendage into the cavity of the auricle, and the clamp is removed altogether If the patient is fibrillating, if there is a history of previous embolism, or more particularly if thrombi which cannot be flushed out are still present in the appendage, the anaesthetist should be asked to compress the carotid arteries in the neck during the insertion of the finger If this is done any dislocated pieces of clot will be much less liable to reach the cerebral vessels. Similarly if the valve is heavily calcified, carotid compression should be undertaken during the manipulation of the valve, as "calcium emboli" might otherwise cause cerebral damage.



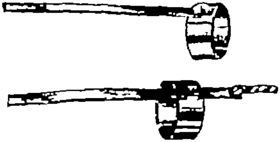
Commissurotomy

5 The valve is palpated and the absence of significant mitral incompetence is confirmed. The finger is thrust through the mitral orifice, and pressure is exerted first in the direction of the postero-medial commissure and then towards the antero-lateral one



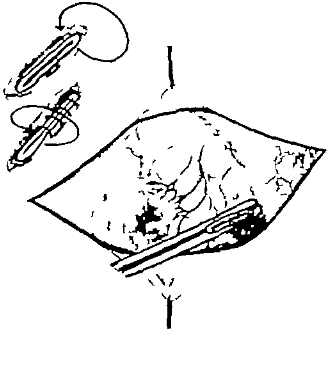
Division with finger knife

6 If complete opening of the commissures cannot be achieved in this way the finger is withdrawn and the clamp is re-applied. A knife is applied to the finger which is then inserted into the auricle. Further attempts are made to complete the division of both commissures right up to the auriculo-ventricular ring



Anterior and posterior commissure knives

7 The anterior commissure knife cuts from the mitral orifice outwards the posterior knife cuts from the periphery of the valve towards the orifice.

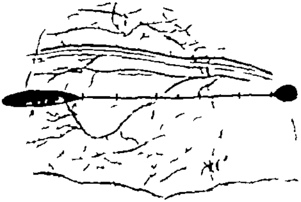


Suture of the appendage

8 With the clamp applied as near to the auricle proper as possible, the redundant part of the appendage is cut off leaving just sufficient to allow easy suturing A No 0 Merslene thread on a 85 mm. half-circle atraumatic needle is used to close the appendage. A running mattress stitch is inserted as close to the clamp as possible, and this is continued as an over-and-over stitch bringing the cut edges of the appendage together The clamp is removed and any bleeding from the appendage is controlled by further interrupted mattress sutures.

Suture of the pericardium

9 The pericardium is sewn with interrupted sutures, leaving gaps at the upper and lower ends of the incision to allow drainage.
A tube is inserted through a stab incision in the tenth intercostal space The wound is sewn in layers.



Approach to the valve via the auricular wall

10 When the appendage is fibrosed and too small to admit the finger or when it is full of clot, the approach must be made directly through the auricular wall. A purse-string suture is inserted, using the same material as that which is used for sewing the appendage. The ring included by the suture must be larger than the diameter of the index finger at the second interphalangeal joint. The ends of the Merulene are drawn through a Rumel tourniquet and are controlled by an assistant. An incision through the auricular muscle is made, great care being taken not to cut the purse-string suture in the process. The finger is inserted through the incision and the valvotomy is carried out in the manner already described. If necessary the finger may be withdrawn and reinserted with a knife, haemorrhage being controlled by the tightening of the purse-string suture. When the operation has been completed the finger is removed and the purse-string suture is tied tightly Further interrupted stitches are inserted if necessary and the wound is closed in the usual way

POST-OPERATIVE CARE AND COMPLICATIONS

The drainage tube is removed between 12 and 24 hours after the operation unless a quantity of blood is still being discharged through it at the end of this period. Where digitalis was being administered prior to the operation it is continued with the dosage unaltered.

A radiograph is taken on the day after the operation, and if atelectasis, a pneumothorax, or a large pleural effusion is present appropriate treatment should be instituted.

Cerebral and peripheral embolism

Cerebral and peripheral embolism are the major hazards of mitral valvotomy Should a cerebral embolus occur a stellate ganglion block should be performed. Peripheral emboli should be treated on their merits an aortic saddle embolus should almost always be treated surgically

Haemorrhage

Occasionally persistent leakage of blood may occur from the auricular appendage. Should this occur it is essential to keep the drainage tube clear and to give sufficient blood by transfusion to keep pace with the loss. If the blood loss becomes severe thoracotomy should be undertaken. The leak in the suture line may then be oversewn.

Auricular fibrillation

This is a frequent sequel to mitral valvotomy When it occurs the rate should be controlled with digitalis, but no attempt should be made to restore normal rhythm until the tenth day after the operation. Possible causes of the arrythmia such as pleural effusion or atelectasis should be dealt with as they arise, and on the tenth day quinidine should be given gradually increasing doses at three-hourly intervals almost always succeed in restoring normal rhythm in those patients where this has not already occurred spontaneously

Post-valvotomy syndrome

The cause of post-valvotomy syndrome is uncertain the treatment is symptomatic, and the prognosis is good. The symptoms and signs are malaise, precordial pain, fever tachycardia, and to a variable extent congestive cardiac failure Radiologically there may be an increase in the pleural effusion, or a pericardial effusion.

Some or all these symptoms and signs may appear at any time between the first few days and the third week after the operation their severity may vary widely The syndrome usually persists for several days but it almost invariably settles with symptomatic treatment.

[*The illustrations for this Chapter on Mitral Valvotomy were drawn by Mr F Price*]

Bibliography

Brock, R. C. (1952). *Brit. Heart J* 14, 490
Sellors, T H., Bedford, D B., and Somerville W (1953). *Brit med. J.*, 2, 1059

PULMONARY EMBOLECTOMY

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PRE-OPERATIVE

Indications

Imminent death from pulmonary embolism. The patient is usually recovering from an operation a fracture or childbirth *Progress should have been normal* until this abrupt calamity for only in that case is there any chance of his withstanding an operation of such gravity The patient will usually be in articulo mortis or at least the surgeon will be satisfied that death is imminent An embolism, to kill the patient from right ventricular obstruction, must occlude more than 70 per cent of the pulmonary circulation It usually lies curled up in the trunk and in both pulmonary arteries

Special contra-indications

This operation is reserved for patients whose cardiovascular and other systems are in good condition but are otherwise killed by this purely mechanical catastrophe

(1) Fatal pulmonary embolism occurs with about equal frequency among *medical* admissions. In view of their general condition the operation should seldom be considered in these.

(2) If the surgeon finds no heart sounds at all when the patient first arrives in the theatre then it is no use proceeding

(3) Patients with post-operative peritonitis or with gas gangrene infection often end up with an abrupt deterioration which may mislead. A study of all the pulse charts since the operation will help in excluding these.

(4) Pulmonary embolism may be diagnosed as acute coronary occlusion but the reverse is rare The aspect of the patient is very different, although the electrocardiogram may be very similar

Special pre-operative organization

This operation is designed to save patients who succumb to the embolism in from ½ to 1 hour Cases who die in a few minutes are not going to be saved in any event. The theatre sister must be specially trained for the operation, and the ward sisters in the symptoms so that they can instantly recognize the cases A Trendelenburg set is kept sterile in a drum, with each instrument in order in its pocket in the roll. Surgeon, anaesthetist, and assistants need regular rehearsing not only in procedure but in speedy assembly The patient will have been given morphine and oxygen. Surgeon and patient will meet in the theatre where a rapid examination is made. If heart beats can still be heard, proceed.

Special instruments

The following special instruments are required Trendelenburg sound, and rubber tubing clot extracting forceps spreader Nystrom clamp wide nozzle suction pump

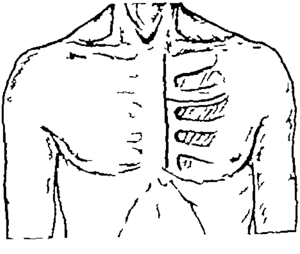
Anaesthesia

Gas and oxygen, cuffed tracheal tube and controlled respiration are ideal, but often the patient will be beyond this at the outset. Nevertheless these measures will be invaluable during resuscitation so the anaesthetist proceeds with his arrangements

Position of patient

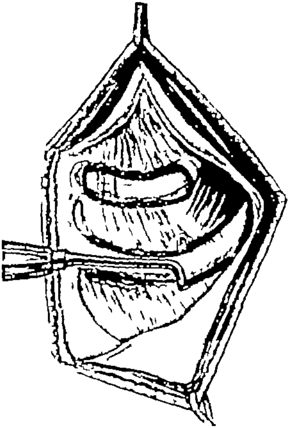
The dorsal position is used with head well raised on account of the orthopnoea. There will be little time fo arrangement of towels and disinfection of the skin. There may be time only to put on a pair of sterile gloves

THE OPERATION



The incision

1 The vertical limb of the incision lies 6 inches over the mid-sternum from the first to the fourth costal cartilage while the horizontal limb extends 6 inches along the lower border of the second rib The incision goes right down to the bone and the two triangles of muscle and skin are turned back off the costal cartilages with a few strokes of the knife. There is hardly any bleeding and no vessels require picking up

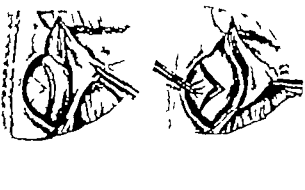


Removal of ribs

2 The third and second costal cartilages are cleared of muscle with the tip of the knife and Doyen's raspatory avoiding damage to the pleura. The costal cartilages are divided with bone forceps at the sternum and the ribs about 4 inches laterally and removed. (Still better access may be obtained by removing the fourth costal cartilage as well, if time allows.)

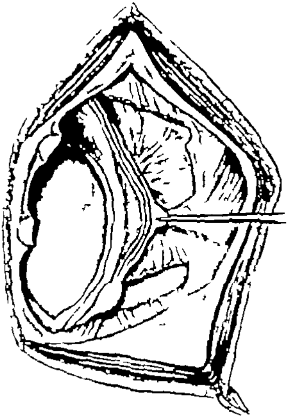
Opening of pericardium

3 The internal mammary artery with its accompanying vein(s) is seen $\frac{1}{2}$ inch from the sternal edge lying on the transversus thoracis it must be avoided—there is no time to tie it This is achieved by the manoeuvre of A. W Mayer as follows the cardiac notch of the pleural reflection is located behind the fourth costal cartilage and enlarged a little by wiping outwards and upwards with gauze The pericardium is then picked up with a fine toothed forceps (this is quite difficult in all cases of massive pulmonary embolism, as the pericardium is made extremely tense by the distended right heart) It is then nicked with the scissors and this is enlarged to about one inch



Reflection of pleura and mammary vessels

4 The two index fingers are then inserted and pulled hard apart so as to tear the pericardial incision up and down in one movement This action automatically reflects the left pleura intact, with the internal mammary vessels lying on it.

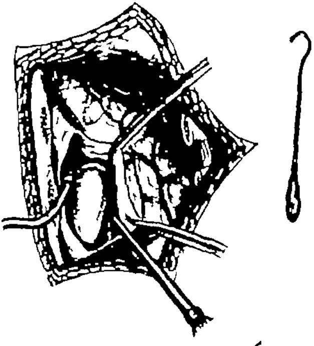


Exposure of heart

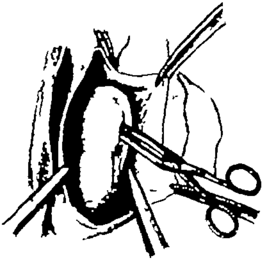
5 The heart now lies exposed in the wound and may still be beating spasmodically

The opening of the transverse sinus is noted when a rubber tube is passed through this behind the two great vessels, it can be used to lift them forwards, as well as to control as far as possible, the haemorrhage

Passage of tourniquet and exploration of pulmonary artery

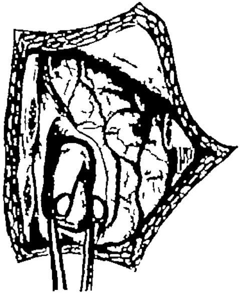


6 The Trendelenburg sound is passed through the transverse pericardial sinus from left to right and the assistant locks the rubber tubing on to its point at the sternal edge. It is then withdrawn taking the tubing with it. (The surgeon should rehearse till he can do the operation to this point in under two minutes.) The assistant now pulls moderately on the rubber tubing forwards and caudally and a vertical incision 1 cm long is made in the pulmonary artery just above its origin. This incision is placed a quarter of the way from the left margin to the right margin of the fused great vessels (owing to greater width and overlap of the aorta) This point must be remembered, otherwise it is the aorta that will be opened. There is much escape of blood from the artery though this is reduced by the tourniquet. The field is kept clear with a wide bore high-capacity sucker and the clot forceps are rapidly introduced three times (1) into the



7 trunk (2) into the left pulmonary artery—almost directly backwards (3) into the right

8 pulmonary artery—this is almost transverse towards the apex of right axilla. The clots are then withdrawn—usually in more than one fragment.



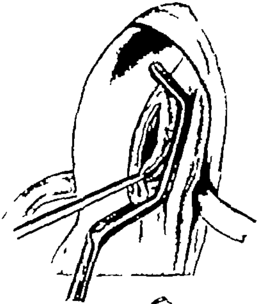
During this exacting part of the operation it is an advantage to have an assistant with a stop watch noting the times. The circulation should not be interrupted for more than a maximum of 100 seconds the surgeon should aim at 60 seconds for the three moves.

Most time is lost in finding the opening quickly each time hence the importance of efficient suction.

If the whole manoeuvre has not been finished in 90 seconds the edges of the incision must be clamped the tourniquet released and the circulation restarted by cardiac massage, before another attempt is made to clear the main vessels. As long as a substantial amount of clot has been removed, such as is judged to leave the greater part of the lumen clear the surgeon should content himself with this and not prolong the search

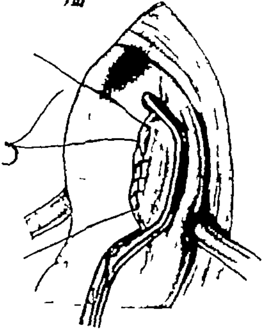
Clamping of incision

9 With the aid of the spreader the incision is securely grasped with the Trendelenburg clamp The tourniquet is released but not removed. The heart has ceased pulsating and the surgeon immediately proceeds with cardiac massage, while the assistant injects (1) 1 ml adrenaline 1 in 1 000 and (2) lobeline into the sinus aortae The anaesthetist carries on controlled respiration with oxygen and CO_2 After some time—probably several minutes—the heart may pulsate Care must be taken that the clamp is still secure especially if strong beats return as cases have been lost through the clamp getting "kicked off" at this stage by the force of the returned heart beat.



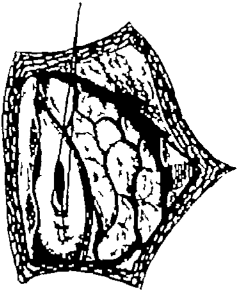
Suture of pulmonary artery

10 As soon as the heart is beating regularly and the patient breathing, the stress of the operation is over and the surgeon can now suture the artery at his leisure. This is preferably done with interrupted silk 4-0 mattress sutures. If it leaks in one place on releasing the clamp as it probably will a fine continuous silk suture can be put in the whole length as a support.



Closure

11 An estimate should now be made of the amount of haemorrhage. It will probably be at least 4 pints. Two pints can with advantage be introduced rapidly into the aorta at this stage. The pericardium is now closed with half a dozen interrupted silk sutures. The pleura must be sutured if torn (in 7 of the dozen successful cases the pleura has in fact been opened) Penicillin and streptomycin powders are placed in the wound in view of the hurried preparations, and the muscle and skin flaps carefully sutured back into position



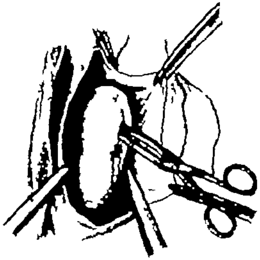
Passage of tourniquet and exploration of pulmonary artery

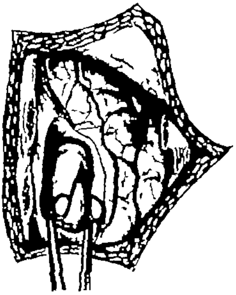
6 The Trendelenburg sound is passed through the transverse pericardial sinus from left to right and the assistant locks the rubber tubing on to its point at the sternal edge. It is then withdrawn taking *the tubing with it.* (The surgeon should rehearse till he can do the operation to this point in under two minutes.) The assistant now pulls moderately on the rubber tubing forwards and caudally and a vertical incision 1 cm. long is made in the pulmonary artery just above its origin. This incision is placed a quarter of the way from the left *margin to the right margin of the* fused great vessels (owing to greater width and overlap of the aorta). This point must be remembered, otherwise it is the aorta that will be opened. There is much escape of blood from the artery though this is reduced by the tourniquet. The field is kept clear with a wide bore high-capacity sucker and the clot forceps are rapidly introduced three times (1) into the
7 trunk (2) into the left pulmonary artery—almost directly backwards (3) into the right
8 pulmonary artery—this is almost transverse towards the apex of right axilla. The clots are *then withdrawn—usually in more than one* fragment.

During this exacting part of the operation it is an advantage to have an assistant with a stop watch noting the times. The circulation should *not be interrupted for more than a maximum* of 100 seconds the surgeon should aim at 60 seconds for the *three moves.*

Most time is lost in finding the opening *quickly* each time, hence the importance of efficient suction.

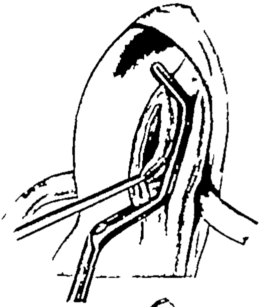
If the whole manoeuvre has not been finished in 90 seconds the edges of the incision must be clamped, the tourniquet released and the circulation restarted by cardiac massage, before another *attempt is made to* clear the main vessels. As long as a substantial amount of clot has been removed, such as is judged to leave the greater part of the lumen clear the surgeon should content himself with this and not prolong the search.





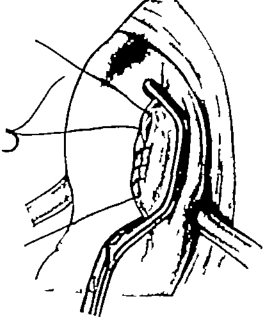
Clamping of incision

9 With the aid of the spreader the incision is securely grasped with the Trendelenburg clamp The tourniquet is released but not removed The heart has ceased pulsating and the surgeon immediately proceeds with cardiac massage while the assistant injects (1) 1 ml adrenaline 1 in 1 000 and (2) lobeline into the sinus aortae The anaesthetist carries on controlled respiration with oxygen and CO_2. After some time—probably several minutes—the heart may pulsate Care must be taken that the clamp is still secure especially if strong beats return as cases have been lost through the clamp getting "kicked off" at this stage by the force of the returned heart beat.



Suture of pulmonary artery

10 As soon as the heart is beating regularly and the patient breathing the stress of the operation is over and the surgeon can now suture the artery at his leisure This is preferably done with interrupted silk 4-0 mattress sutures If it leaks in one place on releasing the clamp as it probably will a fine continuous silk suture can be put in the whole length as a support.



Closure

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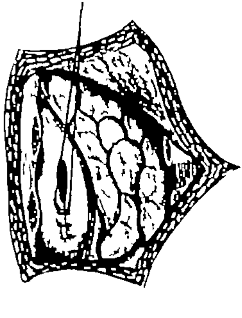

POST-OPERATIVE CARE AND COMPLICATIONS

Immediate post-operative care

Prognosis.—The chances of getting a patient back to the ward alive are probably about 1 in 10 if one sticks to the practice of not proceeding with the operation until the patient is actually dying or dead.

Transfusion.—While the operation is in progress the patient's blood is grouped and cross-matched. Two pints may be rapidly given into the aorta before closing the chest wall—the transfusion is then set up into an arm vein and continued.

An oxygen tent or double nasal catheter is used. If the cerebral circulation has been too long interrupted the patient may not regain consciousness or do so with cerebral damage, such as amnesia or amaurosis.

After-care

Pulmonary complications must be anticipated by constant encouragement to cough and administration of penicillin or other antibiotics as indicated. A "ward" chest x ray should be taken when the patient is back in bed and repeated every morning for a few days.

Recurrence of embolism.—One can tie or "clip" both common femoral veins as a prophylaxis against this.

Infection of wound.—Wound infection with empyema or pericarditis may well occur in spite of antibiotics, and any discharge from the wound should be cultured at an early stage; sensitivity tests should also be carried out.

A SPECIAL NOTE ON THE OPERATION OF EMBOLECTOMY

A number of doubts have been cast on the whole question of the Trendelenburg operation: (1) that the use of anti-coagulants has abolished, or made negligible, the incidence of fatal post-operative pulmonary embolism; (2) that immediate injection of anti-coagulants will prevent a massive embolus killing the patient; and (3) that the operation is so hazardous that it is never justified.

As for (1) it is purely a question of fact; the percentage of hospital admissions dying of pulmonary embolism has remained about one in a thousand for the last 20 years, as has the total number of such deaths in the Registrar-General's returns. In any case the majority of fatal pulmonary embolisms occur in unsuspected cases, where there has been no occasion to give anti-coagulants. It is impossible to conceive how (2) can be effective in the cases which die within an hour or two, for in these secondary clot is not found post-mortem. In the small fraction who are not killed by the embolus for 12–24 hours, the formation of secondary clot may well turn the scales. Of the third criticism this may be said. No surgeon should embark on the operation until he is experienced in diagnosing the condition and used to dealing with grave crises. He must do some simple organizing. Most important of all he and his assistants must have practised the operation together on the cadaver.

The above are the ineluctable pre-conditions of this operation. It does not need numerous staff or expensive equipment, but it does need a good deal of thought and practice beforehand. As for its being "too dangerous"—this objection does not arise as long as it is restricted to the actually dying.

Massive pulmonary embolus is, of all mechanical obstructions in the body, the most terrifying and rapidly fatal. When a virtually healthy person is so stricken, mere defeatism is a poor attitude for a surgeon, when every day there are now performed equally hazardous operations on the heart of persons who will never be well enough to lead normal lives. Moreover, with the advance of anaesthesia and thoracic surgery, it may now be possible to return to free thoracotomy for these cases.*

[*The illustrations for this Chapter on Pulmonary Embolectomy were drawn by Miss D. Davidson with the exception of Illustrations 6, 7, 8 and 11, which were drawn by Mr. J. Wheldon.*]

* The author is working out an operation which employs the left pulmonary artery for the location and extraction of the clot, so as to eliminate the two serious features of the Trendelenburg operation. A new operation of this kind might be made so standard and so much less dangerous that it would no longer be necessary to wait till the patient was in articulo mortis—a practice which now accounts for most of the disappointments of the operation. For in no other condition has the surgeon restricted his chances with so hard a rule.

CARDIAC ARREST

CARDIAC MASSAGE AND TREATMENT

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PRE-OPERATIVE

Indications for cardiac massage

A sudden failure by the heart to act as a pump cardiac arrest can occur in two forms In cardiac standstill, or asystole there is a failure by the specific ventricular tissue to form a stimulus to contract, and in ventricular fibrillation when there are unco-ordinated ventricular contractions. Either may occur first and be followed by the other

The condition is diagnosed when the pulse and blood pressure disappear One must then assume that the output of the heart is inadequate to maintain life. Absence of arterial bleeding when making an incision will confirm this It is right and proper to proceed to thoracotomy with these findings, and it will be extremely rare to find the heart still beating

Aetiology of cardiac arrest

A vago-vagal reflex acting on the auricles probably initiates cardiac arrest. The ventricles then fail to beat spontaneously This failure is often associated with preceding anoxaemia and/or carbon dioxide retention. Previous disease of the ventricles may predispose There is evidence that atropine sulphate is a good pre-operative sedative as it interferes with the action of acetylcholine liberated by the vagus nerve at the auricles.

Time factors

There will be detectable though often reversible signs of brain damage if the brain is without blood circulation for 4 minutes. Six minutes of the same condition will produce permanent damage, even though the heart may be restored to normal rhythm. Preceding anoxaemia may exaggerate the immediate effect of arrest.

Injection of drugs

This is of much less importance than oxygen and massage. The site of injection of drugs for the arrested heart is preferably the ascending aorta proximal to a clamp so that the drug will be driven into the coronary vessels. The left ventricle may be used. Adrenaline introduced into the left ventricle when the muscle is blue will usually be followed by fibrillation When the muscle is pink on oxygen and massage 0 1-0·2 ml. of 1 1 000 adrenaline may be introduced on several occasions to increase tone. Calcium chloride, 2 ml. of a 10 per cent solution repeated as necessary has restored tone to pink muscle When the heart has been beating regularly and the systolic blood pressure has been 80 mm Hg for 10 minutes, it is unlikely that arrest will again occur and the chest wound may be closed.

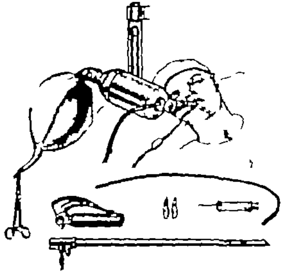
Special equipment

Instruments required are intra-tracheal tube rib spreader aortic clamp and 1 cc. and 10 cc. syringes with long needles. Drugs needed are adrenaline 1 1 000 ampoules calcium chloride 10 per cent in 10 ml. ampoules, and noradrenaline, 4 mg ampoules, for addition to a litre of saline

THE OPERATION

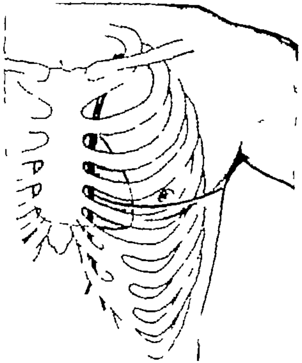
Administration of oxygen

1 The object is to distend the lungs intermittently with pure oxygen. The airway must be cleared and the need for tracheobronchial suction is best eliminated by trial. The oxygen may be given through a face mask temporarily although this is second best to the use of an intra-tracheal tube.



The incision

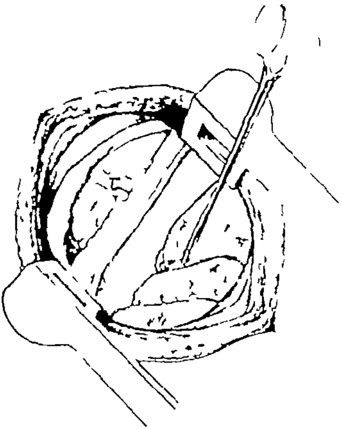
2 *The skin and intercostal incisions need to be* as liberal as the supine position allows. An approach through the fourth or fifth interspace is satisfactory. Unrecognized division of the internal mammary artery has caused death by haemorrhage upon resumption of the heart beat.



3

The exposure

Separation of the ribs by a retractor and the vertical incision in the pericardium are not in the first moment necessary If the heart beat does not return at once they will be desired as it is clumsy compressing the heart from without the pericardium and inspection is required to detect fine fibrillation



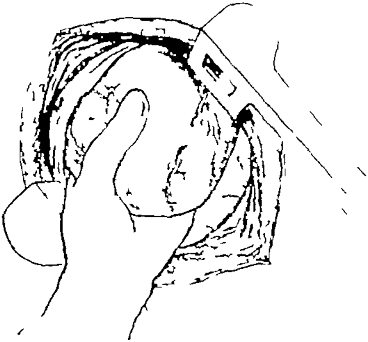
Massage

Massage by *intermittent manual compression* of the heart associated with intermittent distension of the lungs with pure oxygen should be carried out for at least 20 minutes before hope is abandoned. Cyanosis fixed pupils and lack of spontaneous respiration indicate death having occurred.

4

Method using one hand

The one-handed method of compression allows the free use of a hand, for instance to insert a rib spreader and to compress the descending aorta. Efficient cardiac compression squeezes the blood from the apex to the base and will produce a palpable pulse and a systolic blood pressure of 60 mm. Hg

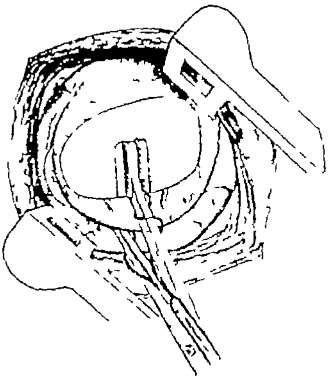


Method using both hands

5 Approximation of the flat hands placed on the anterior and posterior aspects of the heart makes the most efficient pump Sixty compressions a minute is a suitable rate with which to commence Fine adjustments in rate can be made to fit the palpable ventricular filling

Defibrillation

6 When massage has relieved the cyanosis of the heart muscle and the ventricles are filling fibrillation is treated by electrical shocking The large electrodes are placed on the anterior and posterior aspects of the heart in even diffuse contact with the muscle to prevent burning A shock of 200 volts of 0 1 second duration with an alternating current of 50–60 cycles per second may be given to an adult. This may be required to be repeated three or four times at intervals of some seconds. When successful asystole occurs followed at once or in a few minutes by regular ventricular beats, cardiac massage having been maintained since the shocks.



POST-OPERATIVE CARE

Adequate respiratory exchange

Pulmonary ventilation must be continued until a good spontaneous tidal volume is produced, when oxygen will be given continuously. Secretions in the tracheo-bronchial tree must be quickly and carefully removed. Tracheotomy followed by repeated suction should be performed if the secretions are not removed by coughing.

Circulation

Noradrenaline is a very useful peripheral vasoconstrictor without adverse local effects on the heart. This may be needed intravenously immediately after defibrillation and for several hours to maintain a systolic blood pressure of 90 mm. Hg.

Cerebral damage

Restlessness is more likely due to the previous effects of cerebral anoxia than to pain and sedatives should be used cautiously.

Feeding by a gastric tube may be necessary and major bladder disturbances will require appropriate treatment. Daily movements and protection of paralysed limbs must be remembered.

Astonishing recovery of mental and motor function may occur over the following year and some optimism in prognosis may be held.

[The illustrations for this Chapter on Cardiac Arrest were drawn by Miss J. Dewe.]

Bibliography

McMillan, I. R. K., Cockett, F. B. and Styles, P. (1952). "Cardiac Arrest and Ventricular Fibrillation." *Thorax*, 7, 205.
Milstein, B. B., and Brock, R. (1954). "Ventricular Fibrillation during Cardiac Surgery." *Guy's Hosp. Rep.*, 103, 213.
Stephenson, H. E. (1954). "Cardiac Arrest and Resuscitation." *M. Med.*, 51, 870.

TRANSTHORACIC REMOVAL OF TUMOUR (OR CYST) FROM MEDIASTINUM

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PRE-OPERATIVE

Indications

A mass in the *superior anterior* or *posterior mediastinum* may be recognized by chance on a routine radiological examination or in the course of investigations for symptoms. In the absence of symptoms it is usually considered advisable to remove such masses—generally dermoids or cysts. Only serious general contra-indications would justify withholding operation when symptoms already exist.

Special equipment

Rib raspatories and spreader facilities for blood replacement, and a surgical aspirator are required.

Pre-operative preparation

Any respiratory infection should be treated by appropriate antibiotic therapy—based upon an assay of the sputum—for a few days before operation. A radiological examination of the chest should be made immediately before operation, lest some new pulmonary infection or atelectasis or change in the size of the mass has occurred since completion of the investigation. Instruction in breathing exercises should be started by the physiotherapist a few days before operation.

Anaesthesia

General anaesthesia is necessary with intravenous barbiturates and relaxants for induction. Anaesthesia is maintained with nitrous oxide and oxygen, with an intratracheal tube for ventilation and aspiration Intubation is essential. Special difficulty may arise where severe dyspnoea and cyanosis are present with large tumours or cysts. These symptoms may be so greatly exacerbated when the patient is turned on to the side that the towelling and incision may have to be performed at emergency speed. *Relief usually follows opening of the chest when the* lung may be more adequately ventilated. If this does not suffice the volume of the cyst will have to be reduced by aspiration of its contents or a solid tumour shelled out as rapidly as possible—under the latter circumstances there is great risk of shock and haemorrhage from damaged blood vessels.

Position of patient

For removal from the *superior* or *posterior mediastinum* the patient is placed on the right side with a pillow under the chest and a support fixed to the edge of the table to prevent rolling forwards. Alternatively a Sellors's chest support may be used. The left arm is drawn well forward and upwards against the side of the face so as to draw the scapula out of the line of the incision.

For removal from the *right anterior mediastinum* the patient is placed on the left side with the right arm drawn forward as described.

Arrangement of the towels

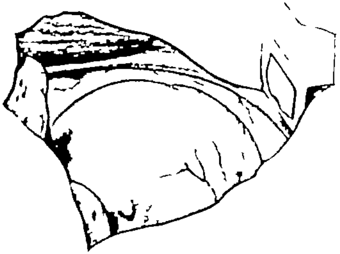
Towels are arranged so as to expose in the case of removal from the *superior* or *posterior mediastinum* the whole of the left hemithorax For removal from the *right anterior mediastinum* it is necessary of course to expose the right hemithorax Other towels are arranged—with the aid of the anaesthetist—over a screen so that the face may be observed throughout the operation and to permit frequent estimations of pulse and blood pressure.

THE OPERATIONS

REMOVAL FROM SUPERIOR MEDIASTINUM

The incision

1 The incision is along the whole length of the fourth rib the approach may be intercostal but it is often convenient to remove the rib itself

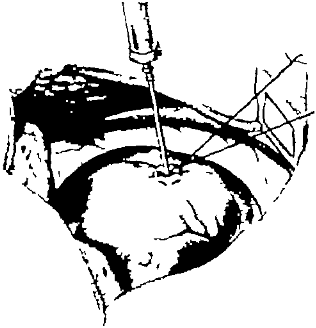


Exposure

2 The pleura is opened and the ribs widely separated by a self-retaining retractor The tumour presents from the anterior mediastinum as a mass pushing the lung backwards.

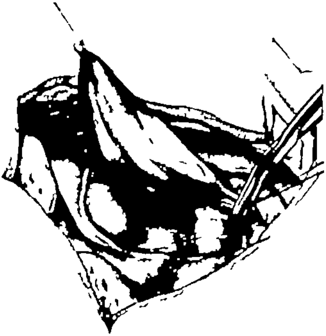
Aspiration of cyst

3 Where the mass is cystic and its size such as to be either difficult to mobilize otherwise or causing serious respiratory difficulty reduction in its size by aspiration is helpful. A large needle is passed into the cyst—the point of the entry having been surrounded by a purse-string suture—and the contents sucked out.



Mobilization

4 An incision in the mediastinal pleura around the margin of the mass has been made and the collapsed cyst dissected out of the space in which it lies, care being taken to avoid unnecessary harm to underlying structures such as pericardium, thymus, aorta, pulmonary artery and phrenic nerves, and the pleura covering the right side of the mediastinum. If the last is opened, it should be repaired if possible the anaesthetist co-operating to prevent collapse of the right lung.



5

Removal of the cyst

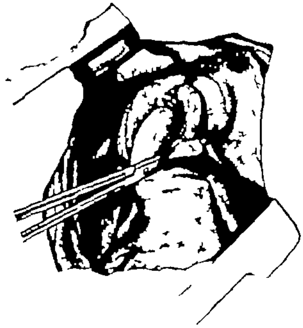
Any pedicle which may contain vessels is divided between ligatures and the cyst removed.

6

Final inspection and closure

The bed from which the cyst has been removed is carefully inspected for bleeding points and damage—requiring repair—to underlying structures. Repleuralization is not necessary. After providing for siphon drainage by inserting an intercostal tube into the lower part of the pleura the wound is closed in layers.

REMOVAL FROM POSTERIOR MEDIASTINUM

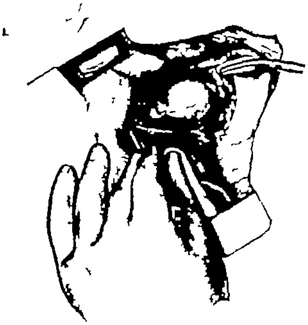


Exposure

7 Approach is by postero-lateral thoracotomy—in the case illustrated through a left interspace. The pleura is opened, the ribs spread apart by a self-retaining retractor and the lung drawn forwards revealing the mass. This lies behind the stem bronchus and the aorta curves round it, above and posteriorly

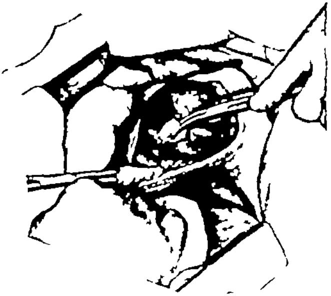
Mobilization

8 An incision encircling the mass is made in the overlying mediastinal pleura and the mass mobilized by scissors, swab or digital dissection as may be expedient.



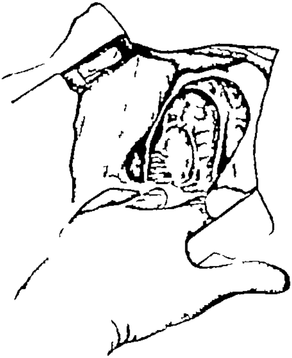
Freeing from deeper structures

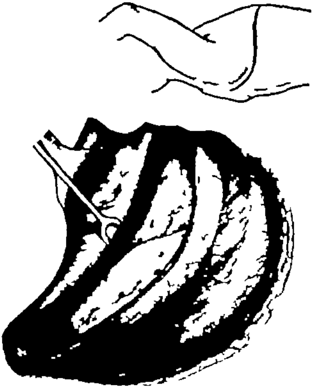
9 The mass is retracted—either by swab pressure or by a holding haemostatic or tissue forceps—away from important structures in its vicinity so that the connective tissue between it and these structures may be put under sufficient tension for safe division. Anteriorly these structures are the pulmonary artery, stem bronchus, bronchial vessels and the vagus nerve and its recurrent branch. The oesophagus—recognition of which by passing a stomach tube is helpful—lies deep to the mass. Above and behind, the aorta with its bronchial and oesophageal branches must be visualized as far as possible by retraction whilst the mass is being dissected away from them.



Final inspection and closure

10 The bed from which the mass has been removed is carefully inspected for bleeding points and damage to other structures. Repleuralization is usually unnecessary and after a tube has been passed between two lower ribs postero-laterally so as to provide for siphon drainage the wound is closed in layers.

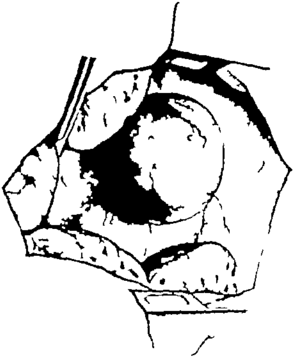




REMOVAL FROM RIGHT ANTERIOR MEDIASTINUM

The incision

11 The incision is along the whole length of the fourth rib. Approach may be intercostal but it is often convenient to remove the rib itself.

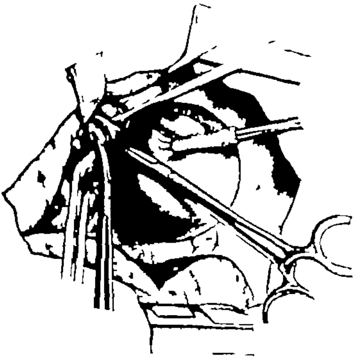


Exposure

12 The pleura is opened, the ribs spread apart by a self-retaining retractor and the mass displayed by holding the lung backwards.

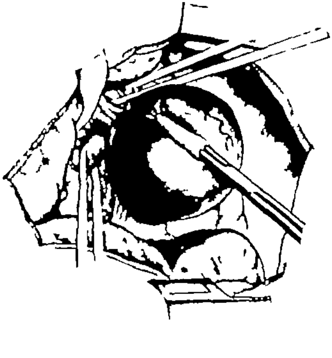
Dissection

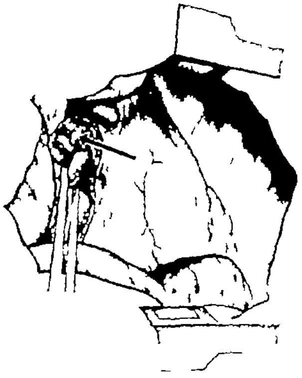
13 An incision encircling the narrowest part of the projecting mass has been made in the mediastinal pleura and a plane for dissection separation identified. This dissection may be digital or by scissors or swab. The upper divisions of the right pulmonary artery are identified and at this stage partially dissected; tapes or silk cords are placed round them for the traction which is helpful in further dissection.



Further dissection

14 The pedicle—here a connexion to the bronchus—is defined, cut across and the mass removed. Any wound in the bronchus is repaired with fine (4/0) silk sutures.





15

Final inspection and closure

The bed from which the mass has been excised is carefully inspected for bleeding points and damage to the bronchus and other structures repaired as may be necessary. Repleuralization is not usually required. After providing for siphon drainage by inserting an intercostal tube the wound is closed in layers.

SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

At the conclusion of operation, before the patient leaves the theatre, a radiograph of the chest must be made lest an atelectasis or an unsuspected pneumothorax—from an unnoticed opening into the opposite pleural space—has occurred. The pleural drainage tube should be retained until there is clinical and radiological evidence that the lung has completely expanded. Whilst this tube is withdrawn—usually 48 hours after operation—pressure with gauze dressing should be made over the tube track so that air is not aspirated into the pleura. The main wound is left undisturbed—in the absence of infection—for 10 days when alternate sutures are removed. The remaining sutures are removed 2–3 days later.

Reactionary haemorrhage

Blood escaping by the drainage tube will usually reveal post-operative bleeding. Should the siphon tube in the drainage bottle cease "working" with respiration, encysted accumulations of blood—or serum—in the thorax will be seen in the x-ray films: these should be taken routinely a few hours after thoracotomy and subsequently each day for the first 3 days. Aspiration of these collections and replacement of blood by transfusion will usually suffice; otherwise the wound must be re-opened, the thorax cleared of clots and bleeding points secured.

Pulmonary affections

Close watch for pulmonary atelectasis and infections must be maintained and the appropriate treatment—postural coughing, breathing exercises, tracheal or bronchoscopic aspirations and appropriate antibiotic therapy—instituted without delay when indicated. Antibiotic treatment for established infections commenced before operation must be continued as may be necessary.

[The illustrations for this Chapter on Transthoracic Removal of Tumour (or Cyst) from Mediastinum were drawn by Mr D. P. Hammersley.]

EXCISION OF INTRATHORACIC GOITRE

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PRE-OPERATIVE

Indications

The radiological recognition of a superior mediastinal mass alone or accompanied by symptoms such as dyspnoea, dysphagia, venous obstruction or thyrotoxicosis. In the absence of general contra indications intrathoracic goitres should be removed on recognition—even when symptom-free—lest complications such as malignant changes or sudden increase in size from haemorrhage occur

Special equipment

A surgical aspirator and sternal shears and retractor will be necessary Facilities for blood transfusion should be available

Pre-operative preparation

Thyrotoxicosis should be treated as indicated under Sub-total Thyroidectomy Volume 4 Part VIII, page 5 Respiratory infection likely to be associated with tracheal compression should be treated by appropriate antibiotic therapy—based upon the sputum organisms—for a few days Routinely a radiograph of the chest should be made immediately before operation, lest some new pulmonary infection or atelectasis or change in the size of the mass has occurred since completion of investigation

Anaesthesia

General anaesthesia, with intravenous barbiturates and relaxants for induction is satisfactory and is maintained with nitrous oxide and oxygen. An intratracheal tube for ventilation and aspiration is required. Intubation is essential, especially when the trachea is compressed.

Position of patient

A low pillow is placed between the shoulder blades to extend the neck and the table is tilted so that the head is about one foot higher than the feet

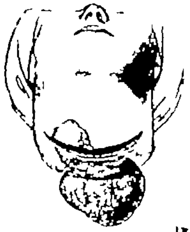
Arrangement of towels

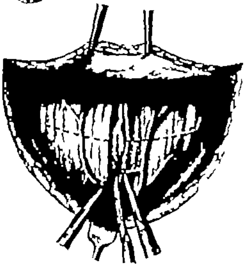
After the skin preparation two towels are placed under the head, the upper being folded over the head so as to cover it completely from the chin upwards and is stitched to the chin the lower is opened out and tucked down below and behind the shoulders. The anaesthetist arranges the towels so that they are held off the face by a screen then the colour and appearance can be watched throughout. Other towels and sheets are placed on each side of the head and neck and over the trunk so as to leave the front of the neck and thorax exposed to the mid-epigastrium.

THE OPERATIONS

CERVICAL ROUTE

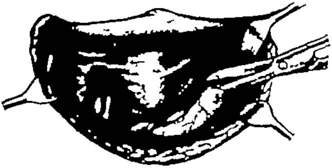
[*See also Cervical Approach to Retrosternal Goitre Volume 4 Part VIII, page* 21]





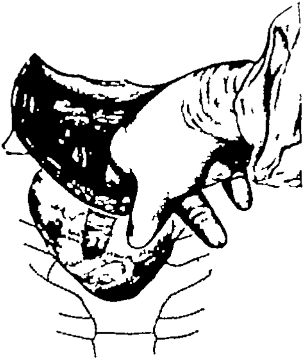
The incision

1 This parallel to or in a crease of the neck, is about 6 inches long and passes close to the upper border of the sternum in the neck line. The platysma is divided in the line of the incision and the skin fascia and the muscle are dissected upwards as far as the thyroid cartilage. Skin towels are then applied to the wound edges which are kept apart by a small self-retaining retractor The depressor muscles of the thyroid are divided transversely so that uninterrupted access may be obtained.



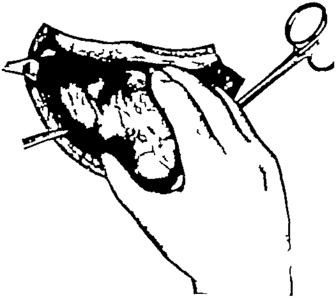
Exposure

2 If there is no associated goitre in the neck then the fascia over the upper edge of the mediastinal mass—which is usually palpable—must be incised to obtain access to the space in which the goitre lies.



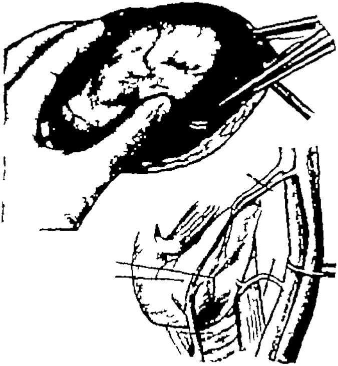
Freeing of adhesions

3 The surgeon passes his forefinger down into the mediastinum within the fascial confines of the space containing the goitre and sweeps it gently *round the latter* freeing it from adhesions. The possibility—although slight—of areas being adherent to large veins and the necessity of avoiding damage to the latter must be kept in mind.



Delivery of goitre into wound

4 The mass is then manipulated upwards into the neck and delivered from the wound. If this cannot be *done with ease and it almost* always can it is preferable to split the sternum and do the remainder of the operation under vision. The mass is usually in front of, but may be behind the great vessels in which case also—especially *if there is any difficulty* in delivering the mass—it will be preferable to split the sternum.



Exposure and division of vessels

5 The superior thyroid vessels are dealt with as in an ordinary cervical thyroidectomy being divided between ligatures at and close to the upper pole of the gland. The middle and inferior thyroid veins, being easily torn, are dissected with care, ligated and divided individually The inferior thyroid artery is exposed by traction of the gland and dissection in the back of its false capsule. Before it is divided between ligatures the recurrent nerve should be identified lest it be inadvertently injured. It may sometimes be felt as fine cord or thread against the tracheal rings.

Toilet of gland bed

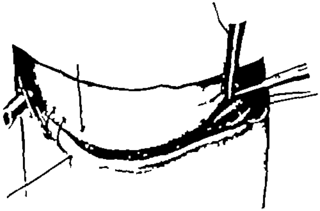
6 After the gland is freed from its main attachments it is usually easily freed completely and removed. The resultant space should be carefully inspected for bleeding and as complete a haemostasis as possible obtained.

Closure

7 The wound is closed in layers The depressor muscles the fascia and the platysma are carefully approximated and sutured.

Skin suture

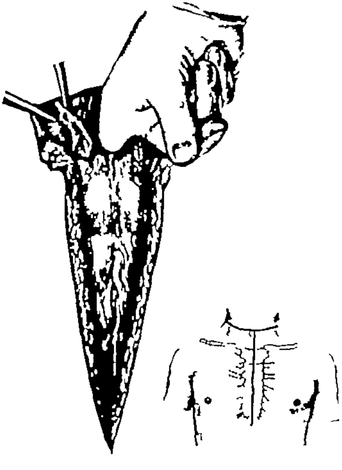
8 Provision is made for a small drainage tube to pass through these layers and the skin which is finally closed by interrupted sutures. Alternatively Michel clips may be used for this approximation The drainage tube should be withdrawn after 48 hours and should not of course be used if the pleura has been opened inadvertently lest air be aspirated continuously into the pleura. If the pleura has been opened siphon drainage should be provided



STERNAL SPLITTING ROUTE

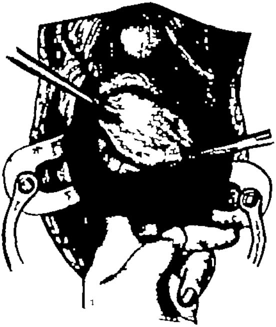
The incision

9 The cervical incision for thyroidectomy will already have been made and the necessity for additional exposure by splitting the sternum decided A vertical incision is made in the midline downwards from the incision in the neck along the whole length of the sternum. The preliminary infiltration of the tissues down to and including the periosteum in the line of the incision with adrenaline (1 800 000) minimizes oozing and helps to delineate the layers for the subsequent resuturing The aponeurotic fibres crossing the sternal notch above often contain a small vessel from which troublesome bleeding occurs this should therefore be divided between ligatures. The surgeon's index finger is passed close to and deep to the sternum so as to strip away the underlying tissues.



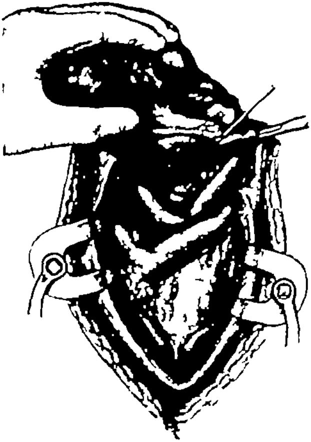
Splitting the sternum

10 The blunt blade of a sternal shears is inserted deep to the sternum which is lifted forward by the shears before they are closed so as to prevent accidental injury to the deeper structures. The edges of the split are held apart by small ribbon retractors and the shears re-inserted as before. This procedure is repeated until the sternum is split along its whole length. A self-retaining retractor is then inserted. Care should be taken to avoid fragmentation of the sternum, which would make repair in closing much more difficult.



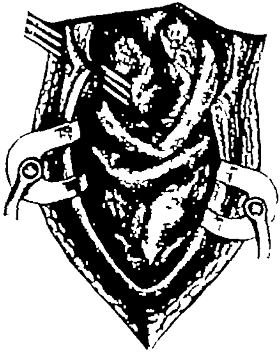
Exposure and mobilization

11 The goitre is mobilized by dissecting until the plane between its false and true capsules is found and then by digital dissection within that plane. This dissection must be gentle as—rarely—areas may be adherent to large veins, damage to which must be avoided.



Completion of mobilization

12 The goitre as it is freed from its bed is turned upwards into the cervical field exposing the vessels—innominate veins and artery and the left carotid artery—and the trachea which it will have been distorting or displacing. Unless already secured during the cervical part of the operation the inferior thyroid vessels of the side associated with the mass must be identified near the upper margin and divided between ligatures, care being taken to avoid damaging the recurrent laryngeal nerve

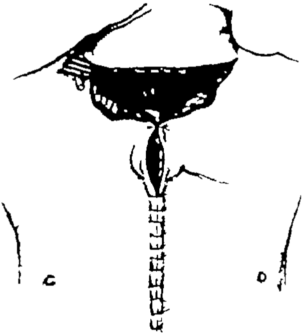


Drainage

13 Bleeding points are controlled and a rubber drain placed in the upper part of the cavity is brought out through one corner of the cervical incision. This drain is removed after 48 hours. Such drainage must of course not be used where the pleura has been opened, in which case siphon drainage of the pleura must be provided

Closure

14 The retractor is removed and the sternal edges approximated by catgut sutures passed through drill holes in or around its two halves The periosteum and fascia are sutured in separate layers and the skin with individual stitches. The cervical incision is closed as already described.



SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

Lugol's iodine should be continued in thyrotoxic cases for a week or so after operation. At the conclusion of operation before the patient leaves the theatre, a radiograph of the chest must be made lest an unsuspected pneumothorax or atelectasis arising during the operation be overlooked. The drainage tube and alternate sutures from the neck wound should be removed on the second day Remaining neck sutures should be removed on the fifth day but the sternal wound should be left undisturbed for 10 days, then alternate sutures may be removed and the remainder two or three days later

Reactionary haemorrhage

Escape of blood by the drainage tube will usually reveal the occurrence of post-operative bleeding Replacement by transfusion will usually suffice otherwise the wound must be reopened and cleared of clots and the bleeding points secured. Should there be no tube or this be blocked, signs of internal haemorrhage and an increased mediastinal shadow will indicate the urgent necessity for taking the patient to the theatre and reopening the wound under anaesthesia.

Pulmonary affections

Close watch for pulmonary atelectasis and infections must be maintained and the appropriate treatment—postural coughing breathing exercises, tracheal or bronchoscopic aspiration and antibiotic therapy—instituted without delay when indicated. Antibiotic therapy for established infections commenced before operation must be continued as may be necessary

[The illustrations for this Chapter on Excision of Intrathoracic Goitre were drawn by Mr D P Hammersley]

OPERATIONS FOR CARCINOMA OF THE OESOPHAGUS

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PRE-OPERATIVE

Correction of malnutrition

A patient suffering from carcinoma of the oesophagus may be in a state of gross malnutrition when first seen and it is most important not to be misled by this into regarding the condition as hopeless nor on the other hand, to undertake any serious surgical intervention until this malnutrition has been corrected. It may be necessary to improve the nutrition before confirming the diagnosis.

Diet

The most important part of the pre-operative preparation is to remove all solid food from the diet and to substitute fortified liquid composed as follows

- 2 eggs
- 2 oz. of sugar
- 1 teaspoonful of salt
- 2 oz. of National dried milk (full cream)
- 1 oz. of butter
- Brandy flavouring, if desired
- 2 pints of milk

The patient should be encouraged to take at least 4 pints of this liquid during the course of 24 hours and in order to achieve this he must have some by his side night and day so that he can take a sip at frequent intervals. It is equally important to ensure that no attempts are made to take solid food, the only effect of which is to block up the small channel left in the oesophagus and to interfere with the passage of the fortified liquid diet. The patient should be given vitamins separately and to vary the monotony of the diet he may be given fruit juice tea or alcohol from time to time Under this regime the patient will usually regain strength, will be able to take walks in the fresh air and practise breathing exercises and prepare himself for the serious operation which lies before him. It is not a waste of time to spend as long as three weeks in this preparation.

Contra-indications

During this period a search is made for any evidence which may make radical surgery unwise or impossible. This includes such features as evidence of involvement of the trachea, bronchi or recurrent laryngeal nerve or the presence of distant metastases.

Improvement of general health

Opportunity is also taken to improve as far as possible any dental sepsis, preferably by cleaning and local measures rather than by wholesale extractions. Any associated condition such as prostatic enlargement should be assessed and it is important to correct the severe constipation from which these patients often suffer

Occasionally it is found that a patient is unable to take even a liquid diet in which case a preliminary gastrostomy must be made, but after a few days it is often found that mouth feeding can be resumed.

Sipping dilute hydrogen peroxide will often help by cleaning away debris and diminishing local sepsis.

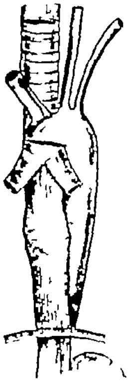
RECONSTRUCTION BY OESOPHAGO-GASTRIC ANASTOMOSIS

The growth may be explored from either the left or right side of the chest according to its situation. If the right side of the chest is used a preliminary abdominal mobilization of the stomach is carried out.

CHOICE OF APPROACH

Left-sided abdomino-thoracic approach

1 If the growth does not involve either the stomach or that part of the oesophagus adjacent to the aortic arch, resection and anastomosis can be carried out satisfactorily by a left abdomino-thoracic approach.

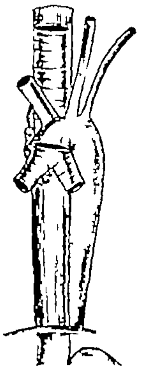


Site of anastomosis

2 The stomach has been mobilized and anastomosed to the oesophagus, which has been divided and displaced to the left of the aortic arch.

Right-sided approach after abdominal mobilization

3 If the growth is situated at the level of the aortic arch, mobilization cannot be carried out satisfactorily from the left side and it is better to make an approach from the midline of the abdomen to mobilize the stomach, and from the right side of the chest to free the oesophagus from the arch of the aorta.



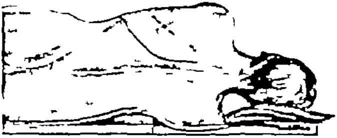
Site of anastomosis

4 The mobilized stomach has been brought up and anastomosed to the oesophagus which has been divided above the level of the aortic arch.

THE LEFT-SIDED ABDOMINO-THORACIC APPROACH

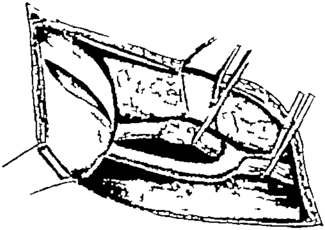
Skin incision

5 The patient lies on the right side with a bridge under the mid-thoracic region The incision is made over the eighth rib and extends forwards nearly to the midline posteriorly the incision curves up parallel to the vertebral border of the scapula The skin incision should reach nearly to the upper part of the scapula so that at a later stage in the operation the scapula may be drawn forward and a high intercostal incision (broken line) made should it be necessary to improve the exposure.



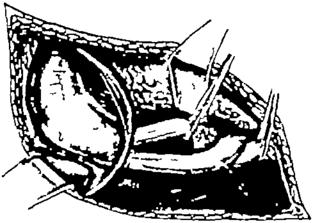
Exposure and mobilization of the oesophagus

6 The eighth rib has been resected. An incision has been made in the peripheral part of the diaphragm and carried outwards to divide the costal margin. The left pulmonary ligament has been divided and the oesophagus freed from its bed both above and below the arch of the aorta. The mobilization of the upper part of the oesophagus has been facilitated by making an incision in the fifth intercostal space. If the growth is firmly adherent to the aorta, the attempt to resect the growth should be abandoned and a short circuit carried out (see Illustrations 27–29)
The intervening ribs are omitted for the sake of clarity



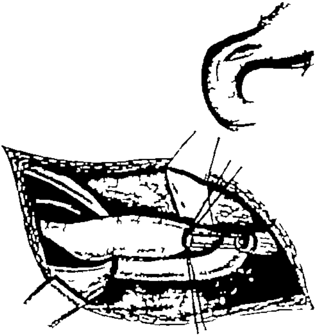
Mobilization of the stomach and division of the pyloric sphincter

7 The stomach has been mobilized by dividing the vasa brevia and the gastro-colic omentum nearly to the pylorus. Care has been taken to preserve the right gastro-epiploic and the right gastric vessels. The left gastric artery and vein have been divided and the pyloric sphincter has been divided without damaging the mucous membrane



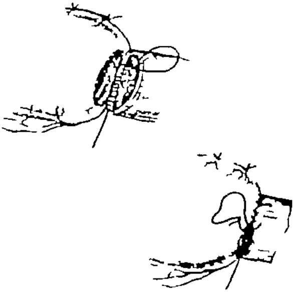
Resection and anastomosis

8 The stomach has been divided distal to the cardia and the incision closed with a running suture of catgut reinforced with interrupted Lembert sutures of thread. The upper cut end of the oesophagus is displaced to the left of the arch of the aorta. In dividing the oesophagus care is taken to divide the mucous membrane at a lower level than the muscle. An incision is made in the fundus of the stomach corresponding in size with the cut end of the oesophagus.



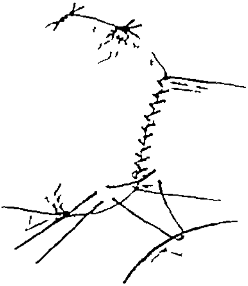
Details of the anastomosis

9 Three mattress sutures of thread have been introduced through all layers of both viscera and tied. A continuous suture of fine catgut is now started posteriorly again passing through all layers, and when it reaches the corner the needle is passed from within outwards through each viscera and is carried on in this manner until it reaches the starting point.



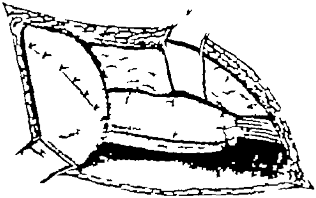
Special stitch at each angle of the anastomosis

10 This stitch passes through the seromuscular coat of the stomach it is then carried up to the pleura a little above the line of the anastomosis, from there to the oesophagus and then back to the stomach When this stitch is tied it draws the stomach up to the oesophagus using the pleura as a pulley The peritoneum of the stomach is thereby brought into apposition with the oesophagus and the pleura is drawn down over the angle A similar stitch is used at the other angle



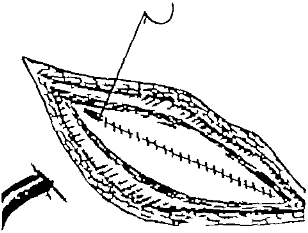
Reinforcement of the anastomosis and closure of the diaphragm

11 The anastomosis is completed by turning a flap of pleura over the anastomosis and suturing it to the oesophagus above and to the stomach below In favourable cases a Lembert suture can be introduced, but often the oesophagus is too friable for this type of stitch to be used. The stomach is stitched to the parietal pleura between the anastomosis and the diaphragm and the diaphragm itself is carefully sutured to the stomach The incision in the diaphragm is closed. All of these stitches are of interrupted thread.



Introduction of intercostal drainage tube and closure of the wound

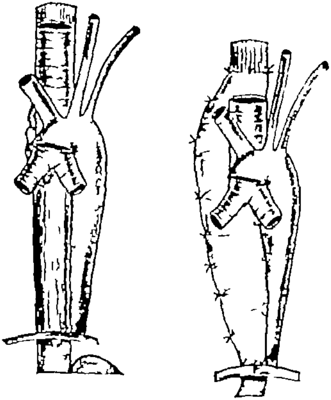
12 A drainage tube (8 mm. internal diameter) is introduced through a separate intercostal incision the end of the tube projecting for 1½ inches inside the pleural cavity A continuous suture of No 8 mono-filament nylon is used to close the incision in the bed of the rib The muscle layers are similarly closed with continuous nylon, and the skin incision with interrupted nylon sutures Gauze dressings are applied and kept in position with short lengths of strapping so as not to impede respiration more than necessary



THE RIGHT-SIDED APPROACH

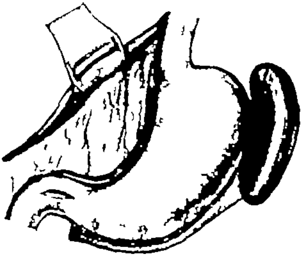
13 This operation is indicated when the growth is situated at the level of the arch of the aorta (*see* Illustrations 8 and 4)

The operation is divided into two stages First, abdominal mobilization of the stomach and, second, a right-sided thoracic approach with excision of the growth and restoration of continuity by means of the mobilized stomach.



Abdominal mobilization of the stomach

14 With the patient lying on his back, a midline incision is made extending from the xiphoid cartilage to the umbilicus. The stomach is mobilized by dividing the gastro-colic omentum, taking care not to damage the right gastro-epiploic vessels. The mobilization is carried upwards between the spleen and the stomach, ligating and dividing the vasa brevia. The left coronary ligament of the liver is divided and the left lobe drawn over to the right side to expose the cardiac end of the stomach and lower end of the oesophagus. The reflection of peritoneum and the phrenico-oesophageal ligaments are divided. The lesser curvature of the stomach is mobilized by dividing the lesser omentum, taking care not to injure the right gastric artery The left gastric vessels are ligated and divided and the mobilization carried upwards to the cardia. The pyloric sphincter is cut, taking care not to injure the underlying mucous membrane. The abdominal incision is now closed, using continuous catgut for the peritoneum, a continuous No. 8 mono-filament nylon for the linea alba and interrupted nylon sutures for the skin. The patient is now turned on to his left side with a bridge under the mid-thoracic region.

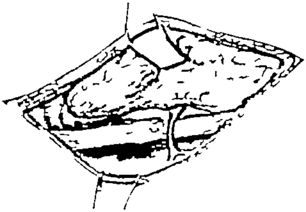


The incision for the right-sided thoracic approach

15 An incision is made skirting the angle of the scapula and reaching nearly to the midline in front and curving upwards posteriorly between the vertebral border of the scapula and the spine The muscle layers are divided and the scapula is retracted forwards. The fifth rib is resected subperiosteally

Exposure of the growth

16 The lung is allowed to collapse. The vena azygos is identified and divided and a part of the vein removed if it is adherent to the growth. The pleura over the healthy oesophagus above and below the growth is incised and the separation of the oesophagus from its bed started at points where the oesophagus is healthy. Great care must be taken not to injure the trachea, the arch of the aorta or the structures at the root of the lung. If there is dense adhesion to any of these structures, the attempt to excise the growth must be abandoned and a short circuit carried out in a similar manner to that described for the left-sided approach (Illustrations 27–29)

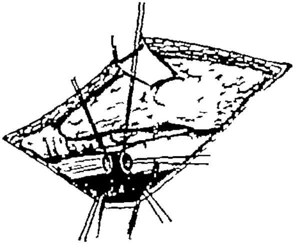


Mobilization of the oesophagus

17 The oesophagus has been separated from its bed from a point 1½ inches above the upper limit of the growth right down to the oesophageal hiatus, and the mobilized stomach has been drawn up into the chest. The cardiac end of the stomach is now divided between clamps and the incision into the stomach closed with a running suture of catgut, and the suture line covered with interrupted Lembert sutures of thread. The oesophagus is divided above the growth, controlling the lower part with a clamp. A clamp is not applied to the end of the oesophagus which is going to be used for the anastomosis. This end is held between stay sutures and the oesophagus is divided in such a way as to leave a margin of mucous membrane (see Illustration 8)

Anastomosis of the oesophagus with the fundus of the stomach

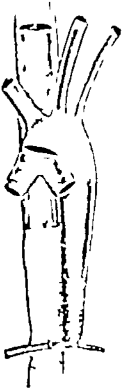
18 The stomach has been divided between clamps at the cardia and the gastric incision closed with a running suture of catgut through all layers reinforced with a layer of interrupted Lembert sutures of thread. An incision has been made in the fundus of the stomach corresponding in size to the cut end of the oesophagus. The cut end of the oesophagus is controlled with stay sutures which are shown. Three interrupted mattress sutures of thread are introduced through all layers of both stomach and oesophagus. All three sutures are introduced before being tied. The anastomosis is then completed as has already been described (Illustrations 8–10) An underwater drainage tube is introduced through a separate intercostal incision and the wound closed in layers using continuous nylon for the muscle layers and interrupted nylon sutures for the skin (see Illustration 12)



OESOPHAGO-JEJUNAL ANASTOMOSIS FOLLOWING RESECTION OF GROWTHS INVOLVING THE CARDIA

Scheme of operation

19 This type of operation involves removing the whole of the stomach and the lower part of the oesophagus together with the spleen, tail of the pancreas, the whole of the greater omentum and the lesser omentum. Continuity is restored by means of a Roux en Y anastomosis of small bowel to the cut end of the oesophagus The situation of the growth suitable for block dissection of the stomach is shown.

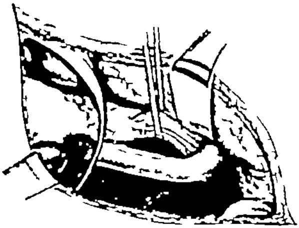


Position after oesophago-jejunal anastomosis

20 The position of the anastomosis after block dissection of the stomach and lower oesophagus is shown

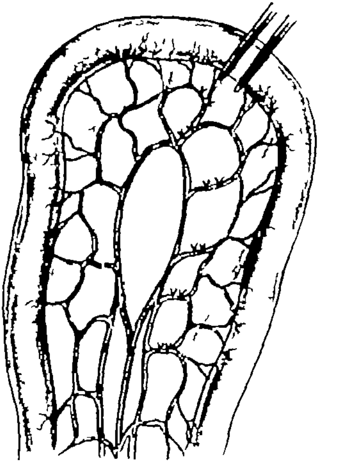
Exposure of the growth

21 A left-sided abdomino-thoracic incision has been made (see Illustration), the eighth rib resected and the costal margin divided. The diaphragm has been divided between stay sutures and the incision carried outwards beyond the costal margin and inwards to the oesophago-gastric junction. In the illustration the right crus of the diaphragm has not yet been divided. The spleen can be seen adjacent to the lower border of the growth and the left lobe of the liver is related to it above. The left pulmonary ligament has been divided and the oesophagus mobilized from its bed and held forward by a rubber tube at a point above the growth



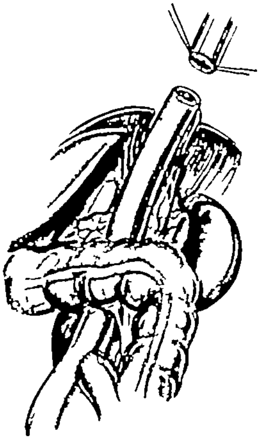
Mobilization of the small bowel

22 A point on the small bowel is selected about 6 inches from the duodeno-jejunal flexure and clamps are applied but the bowel is not divided until the mobilization of the mesentery has been completed. The peritoneum of the mesentery on the side nearer the surgeon is divided and the vessels of the first arcade are divided after each vessel has been secured independently with a fine ligature passed with an aneurysm needle. Mobilization is proceeded with by dividing successive vessels running to the arterial arch and continued until sufficient bowel has been mobilized. In the illustration the arteries only have been shown for the sake of clarity. The bowel is now divided between clamps and the ends are covered with a moist pack until the time comes to make the anastomosis.



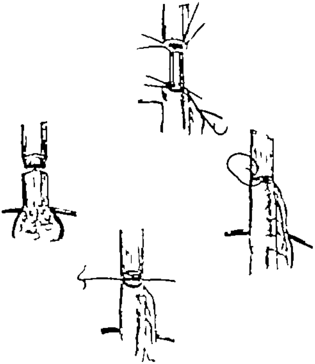
Block dissection of the stomach and lower end of the oesophagus

23 The lieno-renal ligament is divided and the spleen held upwards, together with the left edge of the great omentum. The great omentum is separated from the upper surface of the transverse colon in a bloodless plane and when the separation reaches the region of the pylorus the stomach is held upwards by a hand passed into the lesser sac from below in such a way as to put slight tension on the tail of the pancreas and the splenic vessels. The tail of the pancreas is divided, ligating and dividing the splenic artery and vein in the process. The left gastric vessels are isolated, ligated and divided, and the duodenum is divided between clamps and the distal end closed. The stomach is now drawn up into the chest and the lesser omentum divided. The part of the right crus adjacent to the growth on either side is removed with the cardia. Further mobilization is obtained by dividing the vagi



Division of the oesophagus and oesophago-jejunal anastomosis

24 The oesophagus is divided well above the growth, controlling the cut ends with stay sutures and taking care to leave a fringe of mucous membrane (see Illustration 8) The mobilized limb of small bowel is brought up behind the transverse colon The anastomosis of the distal part of the small bowel to the mobilized segment is usually left to the end of the operation but it is shown here as having been completed for the sake of clarity



Details of the oesophago-jejunal anastomosis

25 The division of the oesophagus is carried out in such a way as to leave a fringe of mucous membrane on the upper segment.

Interrupted mattress sutures of thread are now introduced through all layers of the small bowel and oesophagus on what will be the posterior part of the suture line. Three or four of these can usually be introduced. The stay sutures are not shown

A continuous suture of catgut through all layers is started at the posterior part of the anastomosis and is carried right round to the front. As the corner is turned the needle is passed from within outwards on both sides.

The continuous suture is continued until it reaches its starting point.

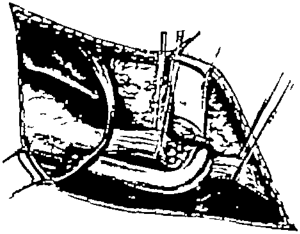
PALLIATIVE OPERATIONS

OESOPHAGO-GASTROSTOMY

This procedure is indicated when an exploration has shown that removal of the growth would constitute an unjustifiable risk. This situation is particularly likely to occur in growths of the middle third of the oesophagus where involvement of the root of the lung or the aorta may be present. The possibility of removal is often difficult to assess and there is a risk that in trying to determine whether the growth is operable damage may be done to one of the important structures mentioned, with fatal results. If careful inspection makes it clear that the removal will be incomplete, it is better to carry out a short circuit.

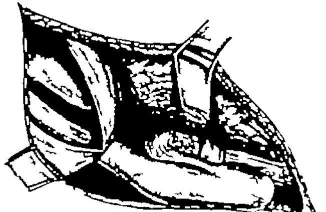
The approach

28 An exploration has been carried out by the left-sided abdomino-thoracic approach (see Illustration 6) and an additional intercostal incision made. The stomach has been mobilized and the oesophagus mobilized as far as the lower limit of the growth and again above the arch of the aorta. At this stage it has become clear that removal of the growth would be inadvisable because it would almost certainly result in tearing the aorta where the growth is firmly adherent. Resection is therefore abandoned and recourse made to a palliative anastomosis.

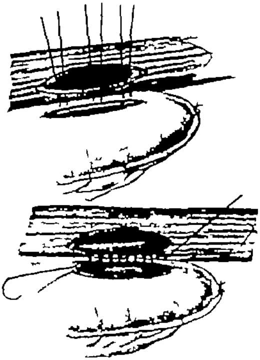


Oesophago-gastric anastomosis

29 The mobilized stomach has been drawn through the oesophageal hiatus of the diaphragm. A longitudinal incision, 1 inch in length, is made in the supra-aortic part of the oesophagus. An incision of exactly the same length is made in the fundus of the stomach, soiling from the stomach being prevented by means of a clamp. A clamp is not used on the oesophagus because of the risk of causing damage but contamination can be prevented by having an aspirator ready when the mucous membrane of the oesophagus is incised.



Details of the anastomosis



30 The anastomosis between the stomach and the oesophagus is carried out by introducing 8 mattress sutures of thread and then a continuous catgut suture which passes right round the anastomosis. The front of the anastomosis is reinforced with interrupted sutures of thread passing between the sero-muscular coat of the stomach and the pleura on the opposite side of the anastomosis. If the wall of the oesophagus is thick, the stitch can also include the muscle of the oesophagus, but care must be taken not to tear the latter An intercostal drain is introduced and the wound closed in the manner described (*see* Illustration 12)

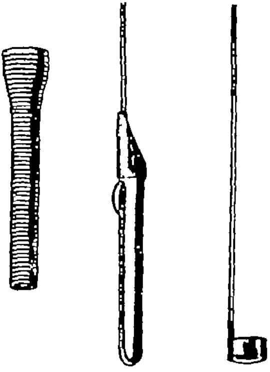
A short circuit can be carried out in a similar way from the right side of the chest.

SOUTTAR S TUBE

By the introduction of a Souttar s tube the lumen of the oesophagus is held open and the patient is enabled to swallow a reasonable diet. The expectation of life is not increased by the procedure. It should be used only when it is clear that the growth is inoperable on account of associated cardiac disease or the presence of metastases, or when a thoracotomy has been carried out and it is seen that neither resection nor a short-circuiting operation is practicable.

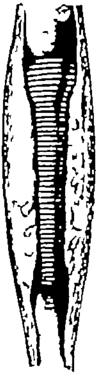
Method of introduction

With the patient anaesthetized, a large-bore Negus oesophagoscope is introduced and the growth inspected. The lumen is sought for and carefully dilated with a series of graduated bougies to prepare the way for the introduction of the Souttar s tube.



31 Souttar s tube of German silver wire is illustrated as large a tube as will pass through the malignant stricture is selected.

An introducer to carry the tube into its proper position and the ring used to hold the Souttar s tube in position while the introducer is withdrawn are also shown



32 **Tube in position**

The Souttar's tube is shown in its correct position with the shoulder of the tube resting on the upper part of the growth.

POST-OPERATIVE CARE AND COMPLICATIONS

Immediate post-operative care

At the conclusion of the operation the patient's bronchial tree is aspirated. On returning to the ward he is put in an oxygen tent if this is necessary but the use of the tent should be discontinued as soon as practicable. The patient should lie flat unless the blood pressure is poor in which case the foot of the bed is raised. The patient should be sat up in bed as soon as his condition allows it.

Sedation

Correct sedation is of the utmost importance sufficient must be given to relieve the pain of breathing but any large dose of morphine or pethidine will produce pulmonary complications by abolishing the cough reflex. The best method is to give frequent small doses (50 mg) of pethidine.

Prevention of accumulation of secretion in the lungs

During the first few days care of the lungs is a most important consideration and every effort must be made to prevent any accumulation of secretion in the bronchial tree and any collection of air or fluid in the pleural cavity

The bronchial tree is kept clear by encouraging the patient to cough and expectorate at frequent intervals, holding the chest firmly to give him confidence, and turning him first on one side and then on the other Breathing carbon dioxide and oxygen at intervals will stimulate coughing Sometimes bronchoscopic aspiration is required. Care of the lungs should be carried out at the same time as other nursing procedures in order that the patient can have sufficient time to rest in between these attentions.

Air and fluid in the pleural cavity

The water-seal drain is inspected frequently to make sure that a negative pressure is being maintained and that there is no sign of the tube having become blocked or kinked. X-ray examination is carried out daily but the results must be interpreted in conjunction with the clinical condition, and if there is any deterioration in respiration, for example, it is important not to be misled by a favourable radiological report when in fact there may be more fluid in the chest than was suspected The intercostal drainage tube should not be removed until the drainage is very small in amount. This will usually be on the fourth or fifth day Care should be taken that air does not enter the chest when the tube is withdrawn and an x ray examination should always be made after this has been done.

Antibiotic cover is maintained for the first week post-operatively

Fluid balance

Fluid balance is maintained by an intravenous drip for the first 4 days after which fluids are started cautiously by mouth. During this period particular attention is paid to the care of the mouth in order to avoid the risk of parotitis.

A Ryle's tube is kept in position for the first 24–48 hours after operation and its tip should lie beyond the anastomosis so that distension of the stomach or small bowel is prevented.

Special complications

Strangulation of small bowel

Occasionally a loop of small bowel will find its way through the incision in the diaphragm and become strangulated The diagnosis is often difficult and unless immediate operation is undertaken the patient is likely to die The best safeguard is to prevent this complication by meticulous suturing of the diaphragm and by attaching the diaphragm to the stomach or small bowel.

Leakage of the anastomosis

If feeding by mouth has been started, fluids should be discontinued and given by intravenous drip It is sometimes safe to continue with small amounts of solid food if the leak does not seem to be large. Sometimes it is necessary to carry out a temporary gastrostomy or jejunostomy

Management of Souttar's tube

A patient with a Souttar's tube should be instructed to avoid any food which may block up the tube, and in general he will not be able to take anything more solid than mince. In addition he should finish every meal with a drink and during the course of the day he should sip a dilute solution of hydrogen peroxide.

[*The illustrations for this Chapter on Operations for Carcinoma of the Oesophagus were drawn by Mr J Wheldon*]

Bibliography

Franklin, R. H (1952) *Surgery of the Oesophagus.* London Arnold.
Ohsawa, T (1933) "Surgery of the Oesophagus." *Arch jap Chir.*, 10 603.
Sweet, R. H. (1954) "Late Results of Surgical Treatment of Carcinoma of the Esophagus." *J Amer med. Ass.*, 155, 422.

OPERATIONS FOR ACHALASIA OR CARDIOSPASM

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PRE-OPERATIVE

Indications

Treatment is indicated in all except the mildest cases and may be carried out in one of the following three ways

Dilatation by means of Hurst s mercury bougie

This method should be employed very rarely and should be reserved for those patients who are unsuitable for oesophagoscopy on account of their advanced age or because there is considerable spinal curvature In such patients the swallowing of a Hurst s mercury bougie every day will keep them free from symptoms.

Dilatation by means of a hydrostatic bag

This may be tried when the oesophagoscopic examination is made.

Heller s operation

This is carried out if dilatation by means of the hydrostatic bag has been tried and failed, or in those cases in which the oesophagus has become lengthened and tortuous as the result of the disease and the introduction of a hydrostatic bag is made very difficult or impossible

The operation consists of a complete division of the muscle at the cardio-oesophageal junction and is carried out either by the abdominal or trans-thoracic approach The latter gives the better exposure in the author s opinion and is less likely to result in failure from incomplete division of the muscle

Preparation of the oesophagus is important in the days preceding the operation in order to get rid of any stagnant food which may be present. With this object in view a fortified liquid diet may be given and the oesophagus washed out every evening with a large stomach tube. The necessity for this will have been indicated at the original oesophagoscopic examination

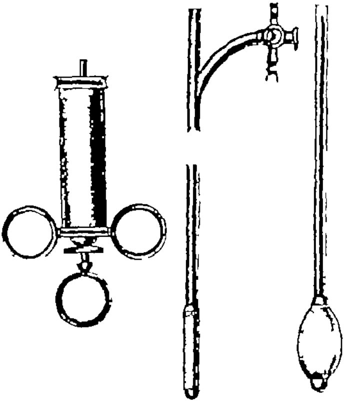
Proper preparation of the oesophagus limits the risk of aspiration pneumonia and as a further precaution the anaesthetic should be given through an endotracheal tube fitted with a distensible cuff.

For the trans-thoracic approach, the patient is placed in the true right lateral position with a bridge or sandbag under the lower ribs.

THE OPERATIONS

Hydrostatic Dilatation by Means of a Plummer Bag

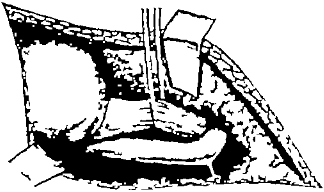
1 The oesophagoscope is passed to confirm the diagnosis of achalasia and to exclude the possibility of reflux oesophagitis with local spasm. It is very important to make this distinction because reflux oesophagitis occasionally simulates achalasia. If the diagnosis of achalasia is confirmed, the Plummer Bag is passed in its undistended state so that the centre of the bag lies below the cardia. The bag is distended with water by means of the graduated syringe and after a few seconds it is emptied and withdrawn half an inch. The process is repeated so as to carry out three dilatations in all. By this manoeuvre it is hoped to ensure that the cardia is thoroughly dilated. Many patients are cured symptomatically by one dilatation. If dilatation is not satisfactory or in cases of advanced achalasia where it may be impossible to introduce the bag, Heller's operation is carried out.



Heller's Operation

Exposure of the lower end of the oesophagus

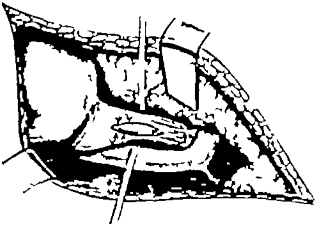
2 The thorax has been opened by excising the eighth left rib. The left pulmonary ligament has been divided, the pleura over the oesophagus incised and the lower end of the oesophagus lifted up from its bed. A small cone of stomach has been drawn up into the chest. Care is taken to disturb the anatomy at the hiatus as little as possible. The rubber tube is shown at the oesophago-gastric junction.



3

Division of the muscle at the oesophago-gastric junction

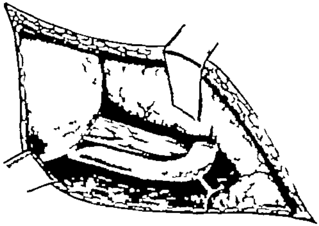
The aim is to make a linear incision dividing the muscle completely so that the mucous membrane of the lower oesophagus and cardiac end of the stomach is freely exposed *It is very important that all the muscle should be divided and it is also important that the mucous membrane itself should not be injured* Any obvious blood vessels on the line selected for the division of the muscle should be ligated. The total length of the incision is usually about 1½ inches



4

Attachment of the oesophago-gastric junction to the hiatus

The cone of stomach has been allowed to fall back into the abdomen and it is kept in place by interrupted sutures of thread, attaching the phrenico-oesophageal ligaments at the phrenico-gastric junction to the margins of the hiatus. This step is important in order to prevent the subsequent development of a hiatal hernia. The thoracic wound is closed after a water-seal drain has been introduced in the manner already described (Part V page 108)



POST-OPERATIVE CARE

HELLER'S OPERATION

Prevention of chest complications

Careful attention is required to avoid chest complications this has been described in the post-operative treatm of carcinoma of the oesophagus (Part V page 204)

Maintenance of fluid balance and resumption of feeding

An intravenous drip is kept going for the first 48 hours and nothing is given by mouth until 24 hours af operation, when 1 ounce of half-strength saline is given hourly for 24 hours. At the end of this time a milk d is started and within 2–3 days the patient should be taking a mixed light diet.

[*The illustrations for this Chapter on Operations for Achalasia or Cardiospasm were drawn by Mr J Wheldon.*]

CONGENITAL ABNORMALITIES OF THE OESOPHAGUS

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PRE-OPERATIVE

ɜral conditions

ny types of congenital abnormality are possible, any one of which constitutes an urgent neonatal problem if left undiagnosed and uncorrected will speedily result in the death of the infant. A possible exception is pe of abnormality where there is a tracheo-oesophageal fistula without oesophageal atresia.

type of oesophageal abnormality most frequently found and accounting for 80 per cent of all the cases exists the upper part of the oesophagus ends blindly at about the level of the vena azygos arch and the lower nt arises from the back of the trachea close to its bifurcation. This type of abnormality will rapidly prove f untreated because the presence of the fistula will allow gastric contents to enter the lungs. On the other this type offers a reasonable prospect of surgical repair because the presence of the fistula indicates that the segment reaches as high as the bifurcation of the trachea.

type of deformity which accounts for nearly all the remaining cases is present where both oesophageal nts end blindly and there is no fistula between the trachea and the oesophagus. At first sight this type would to be more favourable for surgical correction, being uncomplicated by fistula. In practice this is not so e the lower oesophageal segment may not be long enough to allow a straightforward anastomosis to the segment.

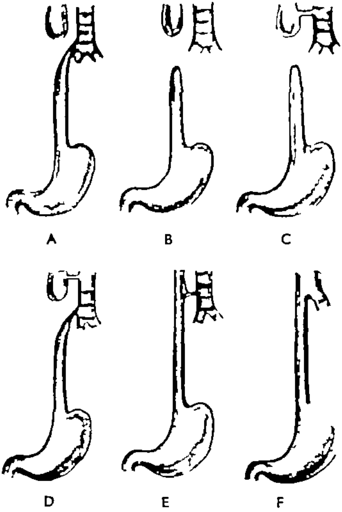
ptoms of congenital atresia of the oesophagus

istent or recurrent cyanosis in the newborn, particularly if associated with excess of mucus in the naso-nx is highly suggestive of oesophageal atresia, and it should not be necessary to wait until feeding has been pted and failed before suspecting the diagnosis. If feeding is attempted, the cyanotic attacks are made worse ıfant may suck vigorously only to be overcome by an attack of choking and cyanosis which is relieved when ed is regurgitated. These signs recur every time a feed is attempted.

irmation of the diagnosis

ubber catheter which has been well lubricated, and which is neither too fine nor too soft, is introduced gh the mouth and passed down the oesophagus. *If its progress is arrested at a level 10–12 cm. from the* ar margin the diagnosis of oesophageal atresia is almost certain. Final confirmation is obtained by introducing l. of iodized oil into the catheter under direct radiological observation. The blind upper segment is clearly ı radiologically and in the rare event of an upper fistula into the trachea being present it will also be seen odized oil is withdrawn The abdomen is inspected at the same radiological examination and if air is present stomach and intestines and the presence of atresia has been demonstrated, it is certain that a tracheo-hageal fistula is present also In this way not only is the presence of an oesophageal abnormality shown but pe of anomaly is determined.

soon as the diagnosis has been confirmed antibiotics are administered by injection and arrangements are to operate without undue delay It should be understood that provided no attempts at feeding are made he blind upper segment is kept empty by aspiration no harm is done by delaying the radiological diagnosis he operation by a few hours.



TYPES OF CONGENITAL ABNORMALITY

1 For the sake of clarity the oesophagus and trachea are shown slightly separated although *in fact they are closely applied to one another*
(A) The upper segment of the oesophagus ends as a blind sac and the lower segment arises from the trachea close to the bifurcation.
(B) Both oesophageal segments end blindly and there is no fistula between the trachea and the oesophagus.
(C) There is a fistula between the upper segment and the trachea.
(D) There is a fistula between both segments and the trachea
(E) There is a tracheo-oesophageal fistula without atresia.
(F) There is a cleft-like deficiency between the upper part of the oesophagus and the trachea and larynx.

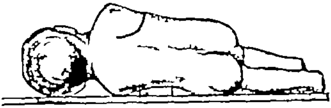
Introduction of a rubber catheter into the oesophagus as the first step in confirming the diagnosis

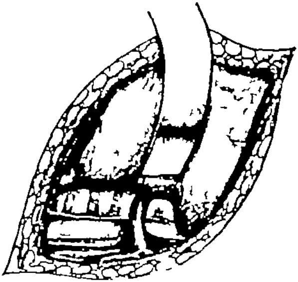
2 The catheter is arrested at a point 10–12 cm *from the anterior alveolar margin*

THE CORRECTIVE OPERATION

The incision

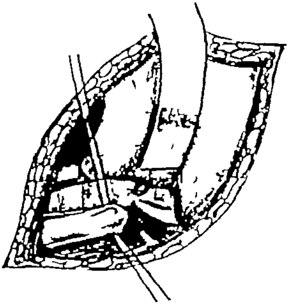
3 An intravenous drip is set up and the anaesthetic is administered through an endotracheal tube. The infant lies in the left lateral position with a small pad under the thorax. The skin incision skirts the scapula and reaches nearly to the midline in front. Great care is taken to secure all bleeding vessels immediately





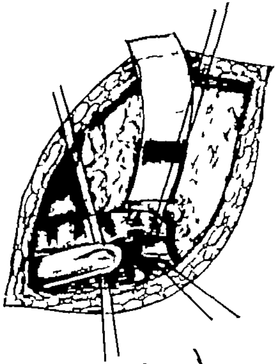
Exposure of the vena azygos arch

4 The thorax has been opened through the fifth intercostal space and the lungs inspected. Any collapsed areas have been encouraged to expand. The lung has been allowed to collapse and the vena azygos arch has been identified



Division of the vena azygos arch and identification of the blind upper segment

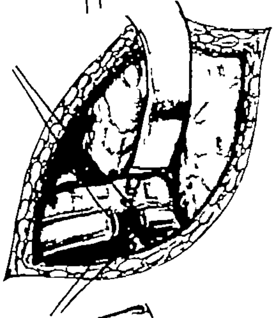
5 The azygos arch has been divided between thread ligatures and the identification of the blind upper segment has been facilitated by introducing a rubber catheter through the mouth and moving it gently in the blind segment. The blind upper segment is held with stay sutures. These sutures and those to be described later are all of 5/0 silk carried on eyeless round-bodied needles.



Identification and separation of the lower segment

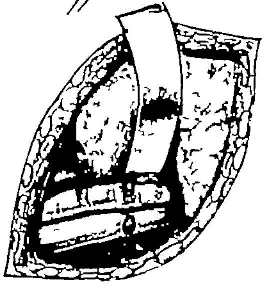
6 This is often difficult. It is important to avoid injury to the trachea on the one hand or to waste oesophagus on the other. The aim is to divide the fistula close to the trachea. The opening in the trachea is closed securely with silk sutures. The lower oesophageal segment is held with stay sutures.

Before proceeding to the next step the lungs are fully expanded and then allowed partially to collapse. This process of inflating the lungs at intervals is repeated throughout the operation.



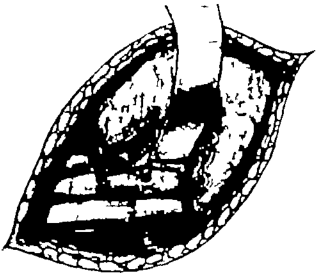
Starting the anastomosis

7 The blind upper segment has been opened. Interrupted sutures have been passed through all layers of both segments of the oesophagus. It is usually possible to introduce 3 or 4 sutures in this way into what will be the posterior part of the anastomosis.



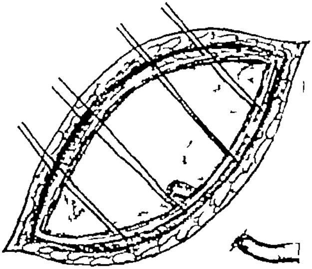
Completion of the anastomosis

8 The posterior sutures have been tied and cut. A rubber catheter has been introduced into the stomach below and up into the mouth above where its end has been recovered by the anaesthetist. The presence of this tube makes it easier to complete the anastomosis.



9 **Testing the closure of the fistula**

The catheter in the oesophagus has been withdrawn after aspirating the stomach empty. A little saline has been introduced into the thorax to see if the trachea is airtight.



10 **Closing the wound**

An intercostal drain has been introduced and connected to a water seal. The lung has been fully expanded. Four pericostal sutures of catgut are shown. These are now tied and the muscle layers are closed with continuous catgut and the skin with interrupted nylon sutures.

SPECIAL POST-OPERATIVE CARE AND COMPLICATIONS

Immediate post-operative care

During or after the operation the child may require 40–60 ml. of blood. The intravenous drip should be continued for 4–5 days and the fluid and electrolytic balance supervised meticulously. For the first few hours an oxygen box will be necessary but as soon as the infant can breathe easily without its aid the box should be discarded. The nasopharynx is aspirated every hour and care should be taken not to introduce the catheter farther than 6 cm. from the alveolar margin in case the anastomosis should be inadvertently damaged.

Nursing

The child is nursed first on one side and then on the other. Antibiotic cover is maintained and an x-ray watch is kept on the chest. If all goes well, mouth feeding is started after 4–5 days and if this is followed by no untoward effects the intercostal drainage tube is removed.

Leakage

Should a leak occur the chest drainage should be maintained, and if the leak shows no signs of healing or seems to be getting worse after 48 hours, it is wise to carry out a gastrostomy before the condition of the child deteriorates.

[The illustrations for this Chapter on Congenital Abnormalities of the Oesophagus were drawn by Mr J. Wheldon.]

OPERATIONS FOR REFLUX OESOPHAGITIS

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PRE-OPERATIVE

The symptom-free hiatal hernia

An uncomplicated hiatal hernia which is not causing symptoms and which has been discovered incidentally does not as a rule require treatment. When pain is the predominant or only symptom medical management should be tried in the first instance

Infants constitute a special problem and every effort should be made to treat the condition by conservative measures, but operation may be called for if radiological examination shows that an associated stricture is increasing in extent.

General indications for operation

(1) If medical treatment has failed
(2) In those cases which are complicated by the development of a stricture at the lower end of the oesophagus.
(3) When pyloric stenosis has occurred as the result of duodenal ulceration.
(4) If the part of the stomach which has entered the chest has itself developed a chronic ulcer

These complications or associated lesions may occur separately or in combination

Type of operation required

Operation for improving the anatomical arrangements at the cardia

This operation is suitable for those patients who have failed to respond to medical treatment but who have not developed a fibrous stricture or the other complications enumerated above.

Total gastrectomy and restoration of continuity by Roux en Y anastomosis

This procedure is indicated when there is a stricture of the oesophagus together with a duodenal ulcer producing pyloric obstruction.

The operation is carried out in a similar way to that described in the case of total gastrectomy for cancer (Part V pages 196–200 Illustrations 18–26) but in dealing with the simple condition the mobilization of the stomach is modified by leaving the spleen tail of the pancreas, and the great omentum untouched.

Excision of part of the oesophagus with restoration of continuity by bringing up the stomach above the arch of the aorta and anastomosing the fundus to the oesophagus

This operation is indicated when there is a very extensive stricture of the oesophagus but the stomach and duodenum are quite healthy

The procedure is the same as has been described in the operation of oesophago-gastrostomy for carcinoma (Part V pages 191–198 Illustrations 5–12)

Partial gastrectomy together with replacement of the stump of the stomach in the abdomen

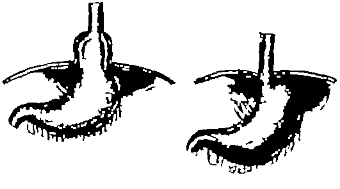
This operation may be indicated when there is an ulcer of the stomach or duodenum with associated reflux oesophagitis, but without stricture formation or severe ulceration of the oesophagus.

In this procedure a partial gastrectomy is combined with the operation for improving the arrangements at the cardia which is described below

OPERATION FOR IMPROVING THE ANATOMICAL ARRANGEMENTS AT THE CARDIA

Aim of the operation

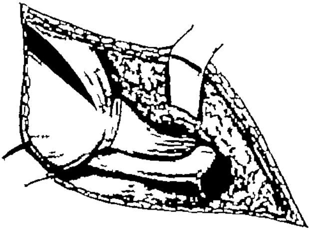
1 This operation aims at returning the stomach to the abdomen and keeping it in place by suturing the phrenico-oesophageal ligaments to the undersurface of the diaphragm, thereby improving the sphincteric arrangement at the cardia and preventing excessive regurgitation into the oesophagus. In addition the vagi are divided in order to reduce the acidity of the gastric contents, and the pyloric sphincter is also divided to make sure that there is no gastric delay as the result of dividing the vagi. This procedure will also ensure that a duodenal ulcer or a pyloric obstruction is not being overlooked.



Repair of the hernia by an abdominal approach (Part III, page 145) or trans-thoracic approach (Part III, page 140) has been already described in Volume 2. The author holds that fixation is *a better procedure and that operative reduction* of the stretched oesophageal hiatus is unnecessary

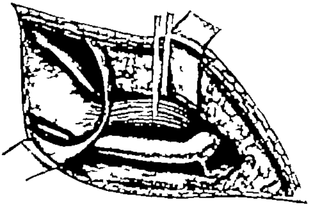
Operative approach

2 The left-sided abdomino-thoracic approach is used as described in Part V page 191 The thorax has been opened and an incision has been made in the diaphragm well away from the hiatus. A hand is introduced through the incision in the diaphragm and the extent of the herniation estimated. The left pulmonary ligament has been divided, care being taken not to destroy the phrenico-oesophageal ligament which is helping to form the hernial sac.



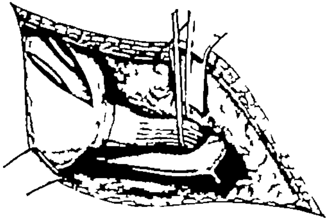
Mobilization of the oesophagus and division of the vagi

3 The oesophagus above the oesophageal attachment of the phrenico-oesophageal ligament has been mobilized right up to the arch of the aorta. Both vagi have been divided.



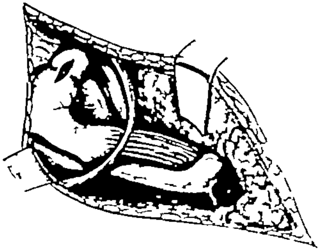
Fixation of the stomach in the abdomen

4 The displaced portion of the stomach has been drawn back into the abdomen the attachment of the phrenico-oesophageal ligament to the oesophagus being used to determine the junction between stomach and oesophagus, and care is taken to see that this junction lies below the diaphragm The stomach is kept in its abdominal position by suturing the phrenico-oesophageal ligament in three or four places to the undersurface of the diaphragm If necessary the fundus of the stomach itself can also be sutured to the undersurface of the diaphragm No attempt is made to reduce the size of the oesophageal hiatus which will soon adjust itself to the size of the structure which it contains.



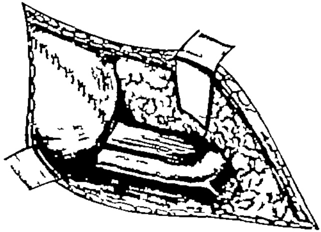
Division of the pyloric sphincter

5 The position of the pyloric sphincter has been accurately determined by palpation and an incision is made so that the sphincter is divided *completely without opening* the mucous membrane



Repair of the diaphragm

6 The incision in the diaphragm has been closed with a series of interrupted thread sutures and a continuous suture of catgut.
The chest wound is closed, after a water-seal drain has been introduced through an intercostal incision, in the manner described (Part V page 198 Illustration 12)



POST-OPERATIVE CARE

Post-operative treatment is essentially the same as has been described in the post-operative care of patients who have been operated upon for cancer of the oesophagus. If resection has not been necessary feeding by mouth may be resumed 24 hours after operation.

[*The illustrations for this Chapter on Operations for Reflux Oesophagitis were drawn by Mr J Wheldon*]

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